

UNDERGROUND INNOVATIONS

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SPECIALIZED EPB FORGES AHEAD

A 4.25 m (13.9 ft) diameter Robbins EPB TBM has been making good progress since December 2008. The EPB is installing tunnel liner never before used in North America, consisting of concrete segments embedded with a PVC inner layer to minimize deterioration by corrosive sewer gases.

The machine was launched to bore Phases 1 & 2 of the Upper Northwest Interceptor (UNWI) sewer project, for the Sacramento Regional County Sanitation District (SRCSD). The 6.1 km (3.8 mi) long tunnel, being constructed by the Traylor/Shea JV, will increase the capacity of the area's current sewer systems.

The Robbins EPB was designed with a spoke-type cutterhead and wear resistant plates for abrasive ground. Muck is removed using a 500 mm (20 in) diameter shaft-type screw conveyor that empties onto a Robbins belt conveyor system.

To tackle curves on the alignment, the machine has been designed using active articulation rather than the passive system. Active articulation allows the front and rear shield to turn independently of the thrust cylinders, eliminating the

common problem of ring deformation in curves.

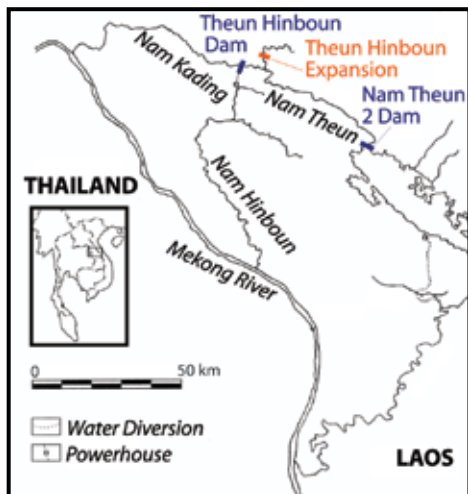
As of February 2009, the machine had advanced well in clay and running sand, and was approaching the first of 20 manholes excavated along the tunnel alignment. The manholes will be used during excavation to check cutter wear and perform cutter changes without the necessity of compressed air, and will be used for routine maintenance of the pipeline after tunneling is complete.

Crews are installing rings in a 5+1 arrangement behind the TBM, which consist of a 230 mm (9 in) thick ring with a 1.75 mm (0.07 in) thick layer of PVC. To meet tight dead-lines, the PVC liner is being welded into a continuous piece during TBM advancement. Gaps between segment rings are sealed together using four inch wide PVC strips, while radial gaps between segments are closed using one inch strips.

Tunneling is expected to be complete in early 2010, when crews will join up the tunnel to nine previously constructed phases of the pipeline. The line is expected to be operational by the last quarter of 2010.



The 4.25 m (13.9 ft) Robbins EPB is using concrete segments embedded with PVC inner liner to prevent corrosion by sewer gases.



The 7.6 m (25.1 ft) diameter Robbins Single Shield will bore a headrace tunnel on the largest tributary of the Mekong River.

ROBBINS EPB TO EXCAVATE CHENGDU METRO

Chengdu, China's 11 million inhabitants will soon have a reduced commute time thanks to an extensive new metro system. Five lines totaling 126 km (78 mi) will be constructed using multiple TBMs.

In January 2009, Robbins signed a contract with China Railway Construction Corp. Ltd. (CRCC) for a 6.26 m (20.5 ft) diameter EPB and back-up on Line 2, Lot 18 of the Chengdu Metro.

Geology will include weathered rocks, with permeable pebbles, sand, and clay. The mixed ground cutterhead will be mounted with both 17-inch disc cutters and carbide bits. The machine will utilize an 800-mm diameter shaft-type screw conveyor for muck removal.

Assembly of the EPB will begin in August 2009 at a facility near Chengdu. The machine is due for an October 2009 launch, and will bore two 1.35 km (0.8 mi) long sections.

The metro will open in three stages, with Line 1 operational by 2010. The 26.7 km long Line 1 will provide service between Honghuayan and Shiji Square stations at speeds of 80 km/h (50 mph). Line 2 will add 50 km (31 mi) and 26 stations. By 2020, the system will be able to accommodate nearly 12.1 million daily passengers and by 2035, 13.1 million.

SINGLE SHIELD WILL CARVE HEADRACE TUNNEL IN LAOS

A new hydroelectric station on the Nam Theun River in Laos will help power up neighboring nations. The Theun Hinboun Expansion project will include a 5.5 km (3.4 mi) long headrace tunnel constructed using a Robbins Single Shield TBM.

The 7.6 m (25.1 ft) diameter machine, for contractor CMC di Ravenna, is being assembled at Robbins' Solon, Ohio, USA manufacturing facility. The Single Shield will be ready for shipment in July 2009.

Optimally designed for squeezing ground conditions, the Robbins TBM will feature an articulating cutterhead and overcutters capable of cutting 100 mm beyond the normal tunnel diameter. As the machine bores, it will line the tunnel with 280 mm (11 in) thick, pre-cast concrete segments in a 5+1 arrangement.

The new Theun Hinboun station will double generating capacity of the current scheme from 220

MW to 440 MW. The station will draw water from the Nam Theun River, the largest tributary of the Mekong, in conjunction with the existing Theun Hinboun power station built by CMC di Ravenna in 1998. Electricity from the plants will be sold to neighboring Thailand, where current power supplies are struggling to meet demands. The project is scheduled for completion in March 2012.

CMC di Ravenna has been contracted for multiple structures on the project by owner Theun Hinboun Power Company, Ltd.--a JV of the Laos Government, Norwegian contractor Statkraft, and GMS Power of Thailand. CMC will build a 1,000 m long starter tunnel and a 45 m (148 ft) deep shaft for TBM retrieval.

Other construction works include a 65 m (213 ft) high regulating dam about 20 km (12 mi) upstream of the existing Theun Hinboun station, a new water intake, and a 1 km (0.6 mi) steel penstock.

SWIFT ADVANCE IN PAPUA NEW GUINEA

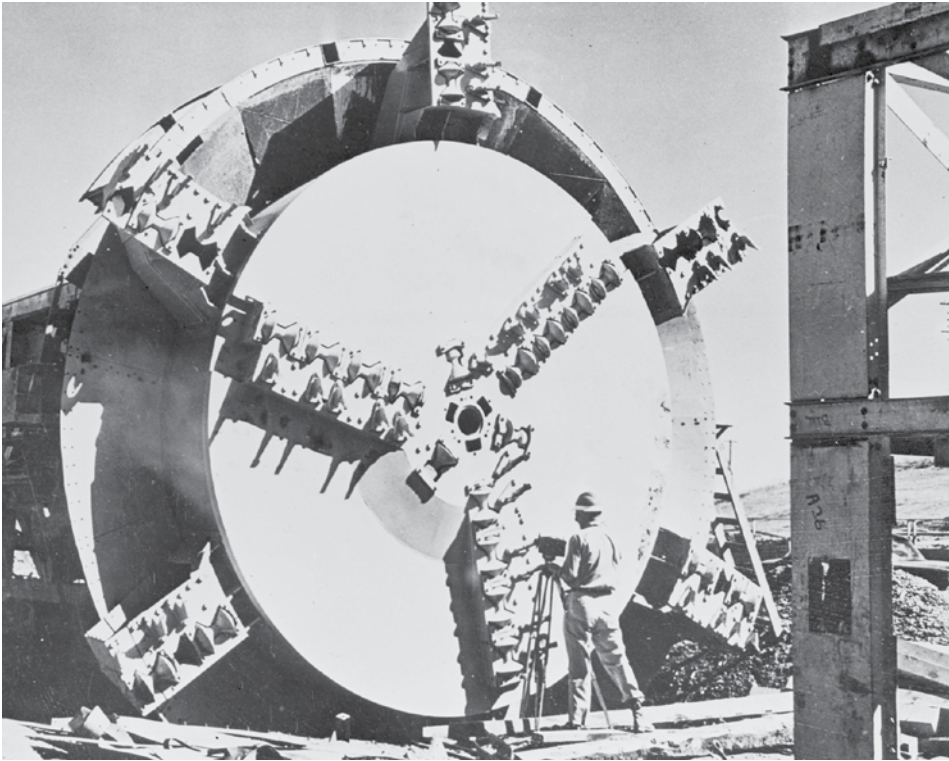


The 5.6 m (18.4 ft) Main Beam TBM was launched in late August 2008 in Papua New Guinea.

The Robbins machine boring in Papua New Guinea has achieved an impressive advance of 2,080 m as of March 2009. The machine began boring five months earlier.

The TBM is boring three dewatering tunnels at the Ok Tedi copper and gold mine, measuring 4.2 km (2.1 mi), 0.9 km (0.6 mi), and 1.2 km (0.7 mi) in length. All three tunnels are located in geology consisting of siltstone, intrusive porphyry, and limestone. An invert thrust system will be used as the machine bores through several expected fault zones.

The tunnels will alleviate problematic flooding in the area, which averages 10 m (33 ft) of rainfall annually. A large lake that has formed at the base of the mine requires draining using the series of dewatering tunnels. Once in place, the tunnels will effectively extend the life of the mine another five years.



Left: James S. Robbins invented the first rock TBM with rolling disc cutters in 1952. Above: Richard Robbins has developed numerous TBM designs since his father's initial inventions, including the first Double Shield TBM in 1972.

RICHARD ROBBINS RECEIVES MEDAL

On April 23, 2009, Richard (Dick) Robbins, President and CEO of The Robbins Company from 1958 to 1993, will accept the Benjamin Franklin Medal for Engineering. He is following in a long line of greats—previous recipients include Albert Einstein, Thomas Edison, Stephen Hawking, and Jane Goodall.

Robbins is being honored for a lifetime of innovation underground—developing TBMs for some of the largest tunneling projects in history. The Franklin Institute Awards have been ongoing for 185 years, and continue to recognize the greatest men and women in science, engineering and technology. A formal awards ceremony will take place in Philadelphia, PA, capping a week of educational presentations and activities. “When I reflect on the process of the award, and the fact that only one engineer is picked per year, I am truly honored and amazed,” said Robbins.

Robbins’ father, James S. Robbins, developed the first rock tunnel boring machine with rolling disc cutters in 1952 and founded The Robbins Company, currently a worldwide company with representation in over 25 countries. Dick Robbins has been responsible for

leading or creating the company’s subsequent innovations, from large diameter hard rock disc cutters to the first Double Shield TBM for Italy’s Orichella Project in 1972.

“One of the most memorable projects I’ve worked on is the Channel Tunnel. We designed machines that successfully bored through water-bearing ground at 10 bar pressure—a much higher pressure than had ever been done before,” said Robbins. The 39 km (24 mi) long Channel Tunnel was completed in 1991 following the use of five Robbins shielded TBMs.

Another career highlight was a machine developed for the RER metro system in Paris, France in 1965. “We created the world’s first below water, pressure bulkhead shielded machine using air pressure. This maintained the tunnel face under pressure while the rest of the tunnel remained at atmospheric pressure. All future slurry and EPB designs had their genesis in this machine.”

Dick continues to work in the tunneling industry as a member of the Board of Directors of The Robbins Company and as a collaborator in development projects.

NEW DELHI EPB SURPASSES RECORDS

In February 2009, one of two Robbins EPBs boring India’s New Delhi Metro conquered a new feat. The machine achieved a weekly advance rate of 168 rings, or 202 m (663 ft)—the highest advance rate amongst any of the 14 TBMs used on the metro project.

Two 6.52 m (21.4 ft) diameter Robbins EPBs were commissioned to bore the BC-16 contract of the New Delhi Metro Extension Project, Phase II. The Continental Engineering Corporation (CEC)/Soma JV is excavating the twin tunnels, which will join Delhi’s Udyog Bhawan and Jor Bagh areas.

“Everyone at CEC is very pleased, and appreciated the performance of the machines,” said Kapil Bhati, General Manager-Operations of the Robbins India office in New Delhi.

The two machines excavated parallel 2.0 km (1.2 mi) tunnels, breaking through into an intermediate cut and cover station at the 1 kilometer mark. The record-setting machine finished its final 1.0 km (0.6 mi section) on March 5, 2009.

The second machine has just been launched on its final section and is scheduled for a final breakthrough in May 2009. Maximum advance rates for this machine have also been very good, topping out at 142 m (466 ft) per week.

MOTORIZED SBU DIGS ON A TIME CRUNCH

Contractor Pacific Boring, Inc. needed a swift solution. In 72 hours, the company had to excavate the first 21 m (70 ft) of a 90 m (300 ft) long trenchless crossing beneath rail tracks. The high-volume rail lines, for the Bay Area Rapid Transit (BART) system in San Francisco, California, USA, could only run on reduced speed for one weekend.

Safety regulations meant that boring could not occur simultaneous with train operation. In addition, the crossing undercut not only the rail line but also a 70 m (230 ft) long section of highway. Line and grade underneath the structures needed to be accurate within 1 ft in predicted hard rock, requiring a method other than conventional Auger Boring Machine (ABM) cutting heads.

Owner San Francisco Public Utilities Commission (SFPUC) in conjunction with Jacobs Associates and Pacific Boring opted for a 1.5 m (60 in) diameter Robbins Motorized Small Boring Unit (SBU-M) for the job—a type of trenchless boring attachment utilizing disc cutters.

The Robbins SBU-M is a manned entry, rock boring machine for use on both long utility installations (90 m / 300 ft and over), and crossings with line and grade requirements. The SBU-M is used with an auger boring machine or pipe jacking unit and can excavate rock from 25 to over 175 MPa (4,000 to over 25,000 psi) UCS.

"We had known about SBUs for a while and heard about them from other contractors that had used them such as Midwest Mole. We were just waiting for the right project with the right geology," said John Iles, Vice President-Operations of Pacific Boring. The contractor selected an SBU-M over other methods such as conventional auger boring. "We didn't feel comfortable going three hundred feet with augers taking all of the cutting torque," said Iles.

Excavation began on a 24-hour basis on Friday, January 31. Pacific Boring was given until Monday morning to make it past the BART tracks. The machine hit a fault zone, slowing advance, though this gave way to better ground where it began averaging about 1 m (3 ft) per hour.

After 72 hours, the Robbins SBU-M had advanced 24 m (80 ft), meeting the project goal. The machine broke through the crossing on March 16, 2009.



Left: The 1.5 m (60 in) Robbins Motorized SBU needed to bore 21 m (70 ft) in 72 hours.
Middle: The 90 m (300 ft) long crossing undercut both rail tracks and a highway in San Francisco, USA.
Photo: Steve Gallyer
Bottom: The Robbins SBU-M made the deadline and completed the crossing by March 16, 2009.



EVENTS CALENDAR

Robbins will exhibit at the following trade shows:

2009

Intermat
April 20 - 25
Paris, France

World Tunnel Congress
May 23 - 28
Budapest, Hungary

RETC
June 14 - 17
Las Vegas, Nevada, USA

Trenchless Australasia
September 20 - 22
Melbourne, Australia

ICUEE
October 6 - 8
Louisville, Kentucky, USA

STUVA
December 1 - 3
Hamburg, Germany

