

UNDERGROUND INNOVATIONS

NEWS FROM ROBBINS



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ONSITE ASSEMBLY & LAUNCH: NORTH LINK

IN A SMALL SITE ALONG A BUSY HIGHWAY, a refurbished 6.65 m (21.8 ft) diameter Robbins EPB made its tunneling debut. The mixed ground TBM, assembled using Onsite First Time Assembly (OFTA), began boring the new North Link Light Rail Extension in November 2014. The rail routes are expected to improve travel times coming from the North into Seattle, Washington, USA, a city with some of the country's worst traffic congestion.

The contractor, JCM Northlink LLC (a JV of Jay Dee, Coluccio Construction, and Michels), is excavating 5.8 km (3.6 mi) of

twin running tunnels through glacial till, and two cut-and-cover stations.

Challenges during tunneling are many—the start of excavation consists of lacustrine clay and unsaturated, dense sands above the water table, which make ground conditioning a difficult process. The location of the tunnels is another cause for concern: “We are tunneling for a mile below the University of Washington campus, with some work required at the surface above the tunnel, and there has been concern about ground-borne noise and vibration,” said Glen Frank,

Project Manager for JCM NorthLink.

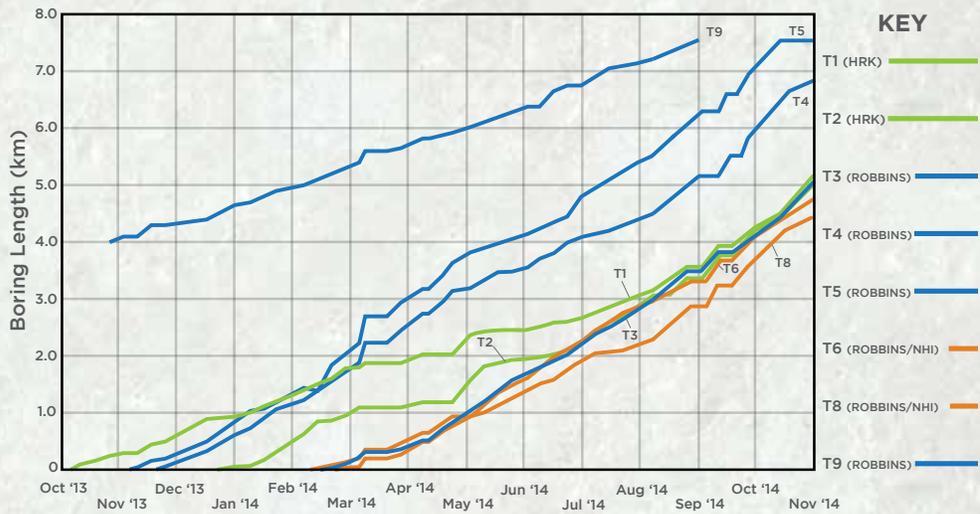
Contractor JCM refurbished a Hitachi Zosen machine for the first of the parallel tunnels, which is operating with a Robbins continuous conveyor system. That machine was launched in summer 2014.

For the second tunnel, JCM chose a Robbins EPB previously used in mixed ground at Singapore's Downtown Line. Robbins designs its machines including EPBs with use on multiple tunnels in mind: components are built up to 33% heavier than other manufacturers, and all parts are designed for 10,000 hours of workable life.

The contractor is seeing increasing use of refurbished EPBs: “10 years ago, EPB tunneling in glacial geology below the water table was not that common, and it would have been considered a big risk to use a refurbished TBM. Now, many EPBs have been specified to deal with more challenging geology, and so there are quite a lot more out there to be refurbished. It increases our ability to get a TBM to launch sooner, and is also more cost effective.”

A Robbins mixed ground EPB was launched in November 2014, following Onsite First Time Assembly (OFTA) alongside Washington State's busy Interstate 5.





Meters advanced at China's Liaoning NOW Project through November 2014.

CHINA CHALLENGE: YIN HAN JI WEI

MOUNTAINOUS HARD ROCK TUNNELING

is never an easy task, but a new 8.05 m (26.4 ft) diameter Robbins Main Beam TBM is up for the challenge. Built in Robbins' Pudong workshop in Shanghai, China, the TBM will excavate a 16.4 km (10.2 mi) long high cover tunnel in granite, quartzite, and diorite up to 168 MPa (24,000 psi) UCS. Joints and fissures are expected in sections, with occasional ground water. In several sections with more than 1 km (0.62 mi) of ground cover, in-tunnel air temperatures are expected to reach 42°C (108°F).

The unique TBM will be operated by China Railway Tunnel Group (CRTG), who are responsible for the long rail tunnel to be owned and operated by Shaanxi Province YHJW Project Construction Co., Ltd.

The hard rock TBM was designed with 20-inch back-loading disc cutters, as well as a versatile ground support system able to install rock bolts, ring beams, and McNally slats. The system of slats allows for consolidation of fractured ground. In difficult conditions, rock bolts will be installed in dense patterns, while dual shotcrete systems will coat the entire bored tunnel. Not one, but six, drills are installed on the TBM, including four roof, one probe, and one core drill to sample rock. As the TBM bores, a 450 kW chiller system will keep air temperatures down.

ROBBINS RAPID ROCK MACHINES AHEAD OF THE PACE

A TEAM OF HIGH-SPEED MAIN BEAM TBMS is working in the mountains of Northeastern China to alleviate chronic drought via a massive water transfer scheme.

The Chinese Government commissioned the Liaoning NOW Water Transfer Project in nine lots, designated T1 through T9. Each lot, excepting T7, is using a TBM to bore two tunnel sections ranging from 6.5 km to 8.0 km (4 to 5 mi) in length. Lots T1 and T2 purchased Herrenknecht

nese equipment supplier NHI contracted with Robbins to supply Main Beams for T6 and T8, and a rebuilt Robbins TBM was provided for lot T9. All eight TBMs are using Robbins continuous conveyors.

The Robbins TBMs are uniquely designed for long distance tunneling in hard rock, and are the first to be supplied in China with 20-inch disc cutters. Versatile ground support systems allow the TBMs to install everything from ring beams to McNally slats in the tunnel crown.

The TBMs launched from October 2013 to February 2014, with the exception of the T9 machine, launched in early 2013.

By November 2014, two Robbins TBMs at T5 and T9 had finished their first sections. Those machines with 20-inch cutters averaged 550 m (1,804 ft) per month, compared with 437 m (1,434 ft) per month where 19-inch cutters were used. Despite launching early in October 2013 and January 2014, the Herrenknecht TBMs at T1 and T2 have experienced significant abrasive wear and are behind the Robbins TBMs by as much as 2.4 km (1.5 mi). Rates at T5 have topped 634 m (2,080 ft) per month. All tunneling is expected to be complete by October 2015.

“The entire Robbins conveyor system is reliable, stable and efficient.”

--Mr. Li Xiao Han, representative for the project owner, on the biggest factors allowing for high advance rates.

Main Beam TBMs. Contractor SinoHydro Bureau 3, responsible for lots T3 and T4, elected for new Robbins Main Beam TBMs, 8.53 m (28 ft) in diameter. T5 contractor Shanxi Hydraulic Engineer Construction Bureau also ordered an 8.53 m (28 ft) Robbins Main Beam. Chi-



DUAL MODE MASTERS

MINE ACCESS TUNNELS IN AUSTRALIA

THE FIRST TBM USED IN COAL MINES

in Australia made major progress this summer when it was successfully retracted from the first of two mine access tunnels. The unique Robbins Dual Mode EPB/Rock TBM is being operated by Anglo American in Queensland, and began its second tunnel in November 2014.

The 8.0 m (26.2 ft) Robbins TBM and continuous conveyor began excavation for the Grosvenor Decline Project in December 2013, which consists of two tunnels in sedimentary rock of 120 MPa UCS, along with sand, clay, and coal seams.

The TBM was chosen over the traditional roadheader method for several reasons including speed—the swift machine has advanced ten times faster than a roadheader. Another reason was maintenance: “The final tunnels need to remain intact for the life of the Grosvenor Mine [about 40 years], and be maintenance-free with cement linings,” said Adam Foulstone, Underground Construction Manager at Anglo American.

The TBM is optimized towards hard rock boring, as only 300 m (984 ft) of each tunnel are in mixed ground. A two-stage, center-mounted screw conveyor works in a variety of ground, while the cutterhead uses interchangeable disc cut-

ters and carbide knife-edge bits.

The first tunnel is at a grade of 1:6 for men and materials; the other at 1:8 for conveyors. The lengths of the tunnels are 1,100 m (0.7 mi) and 950 m (0.6 mi), respectively. Australian tunnels require constant ground support, and the TBM was customized with a Robbins-

“[Use of TBMs] opens up a new chapter not just with Anglo American, but with the whole coal industry in Australia.”

--Adam Foulstone, Underground Construction Manager

designed “Quick Removal System”, which allowed the machine to be removed from the tunnel and retracted from its outer shield bodies, leaving them behind for support. At the second tunnel, a new set of shields was added.

“This is the better methodology,” said Foulstone. “[Use of TBMs] opens up a new chapter not just with Anglo American, but with the whole coal industry in Australia. Now we can draw up a new coal mine in less than a year, compared with two to three years if we use roadheaders.”

HIGH COVER HEAVYWEIGHTS FOR AUSTRIAN HEPP

At a maximum depth of 2,000 m (1.2 mi) below the Alps, Austria's Gemeinschafts Kraftwerk Inn will require serious tunneling. The new hydroelectric plant is being constructed by contractor Hochtief Infrastructure GmbH and includes the “Triebwasserweg Maria Stein”, a 22 km (13.7 mi) long tunnel.

Robbins will supply two 6.5 m diameter Double Shield TBMs for the project. The machines will be assembled in Italy in 2015, and will include stepped shields if any squeezing ground is encountered. Bentonite ports in the front and gripper shields will reduce friction, while the cutterhead will have overboring capabilities. Rock is expected to consist mainly of schist with an average 70 MPa (10,000 psi) UCS. The tunnel is scheduled to be completed in mid-2018 and, once online, will aid in generation of renewable electricity for about 100,000 homes.

CHILE'S NEW MOUNTAIN MACHINE

About 300 km south of Chile's capital Santiago, high in the Andes Mountains, lies the jobsite for the new Los Condores Hydroelectric Project, a massive scheme that will generate an average 642 GWh annually.

The project, for a JV of Ferrovial/Agroman, consists of two tunnels approximately 6.0 km (3.7 mi) and 4.4 km (2.7 mi) in length, to be driven through high cover hard rock.

A new 4.56 m (15.0 ft) diameter Double Shield TBM and back-up system are currently being manufactured in Robbins' Solon, Ohio, USA workshop, with factory acceptance scheduled for spring 2015.

Once at the site, the machine will bore and line the tunnel with 4+1 concrete segments, using a rapid segment unloader to maximize ring build speed.



LEFT: Factory assembly of the Yin Han Ji Wei TBM in October 2014.
TOP RIGHT: Grosvenor's 8.0 m (26.2 ft) Dual Mode TBM.
BOTTOM RIGHT: The Robbins TBM was retracted from its first tunnel using a unique “Quick Removal System” with transport dollies.





LEFT: Robbins Small Boring Units (SBU-As) have been a staple of the auger boring industry since 1996. RIGHT: The Motorized Small Boring Unit (SBU-M) enjoys an equally loyal following among contractors boring line-and-grade-sensitive crossings.

ROBBINS SMALL BORING UNITS MAKE LASTING IMPRESSIONS

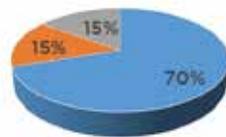
FROM SBU-A TO SBU-M TO ROCKHEAD, Robbins Small Boring Units are making a splash amongst contractors worldwide. In a 2014 survey conducted by Robbins and third-party companies, 100% of respondents ranked SBU products as being good to excellent in terms of quality and reliability. They also nearly universally found Robbins reliable in meeting delivery times, with only one respondent disagreeing, and were overwhelmingly positive with regards to sales and field service support.

The positive results continue a trend in Robbins' annual survey over the last five years that highlights the reliability and efficacy of SBU Products.

In addition to asking about the products themselves, Robbins also wanted to know more about market trends, both for SBUs and for utility tunneling machines such as microtunneling products (also offered by Robbins). Over half (57%) of contractors surveyed had seen the demand for microtunneling machines increasing, while 70% found that the market for hard rock auger boring using SBUs was either increasing or holding steady.

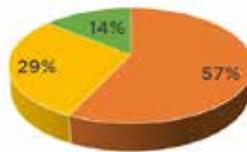
The survey results are an important part of Robbins' market research and strategy, and are repeated annually. We look forward to your participation in 2015!

Is the SBU Market Increasing, Decreasing, or Staying the Same?



■ Increasing ■ Staying the Same ■ It Depends

Is the Microtunneling Market Increasing, Decreasing, or Staying the Same?



■ Increasing ■ Staying the Same ■ It Depends

2014/2015 EVENTS CALENDAR

Robbins will participate in the following trade shows:

bC India
December 15-18
New Delhi, India

UCT
January 25-29
Houston, Texas, USA

NASTT No Dig
March 15-19
Denver, Colorado, USA

ITA-AITES World Tunnel Congress
May 22-28
Dubrovnik, Croatia

RETC
June 7-10
New Orleans, Louisiana, USA



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