Geotechnical Solutions
An Alternative Approach to Soft Ground Tunneling

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In recent years, a variety of geotechnical solutions have been an important element to tunneling projects, especially those in soft ground.

(Photograph provided by Moretrench Corp.)

COVER STORY
Geotechnical Solutions — An Alternative Approach to Soft Ground Tunneling

Soft ground tunneling remains one of the most challenging aspects of underground construction operations. In recent years, a number of tunnel projects owe their success to design and construction approaches that minimize surface impacts and can react quickly to unexpected conditions or events.

By Paul C. Schmall and Kenneth R. Chadwick

FEATURES

Allentown Industries: Built on Experience

When undertaking an underground project, having an experienced partner can be a valuable asset. It is with that in mind that Allentown Industries was created through the 2004 merger of Cellular Concrete LLC and Allentown Equipment.

By James W. Rush

International Focus: Germany

The German tunneling market has been strong for the last 25 years, but the future also looks promising, as a total of 295 miles of new tunnel projects in Germany is expected to be planned for the next 10 to 15 years.

By Alfred Haack

Microtunneling Chosen for Small Alberta Town

For the first phase of St. Albert’s Sanitary Trunk Sewer project, a variety of factors made microtunneling the preferred, if not the only viable, method to relieve its sanitary sewer infrastructure.

By Nick Zubko

Steel Fiber in Concrete Reinforcement

Rebar has become an integral component of concrete segments used in tunnel construction. However, the use of steel fiber reinforcement has recently become an increasingly viable alternative.

By Nick Zubko

Finding a Solution in Austin, Texas

Using the right combination of tools and technologies helped City of Austin officials solve their infrastructure problems.
Old Companies, New Technologies

Through the years, technology has significantly changed the face of the tunneling industry. Hard-rock tunnels, once limited to drill-and-blast, are now dominated by tunnel boring machines. Near-surface projects that were once performed solely by open-cut are being constructed using sequential excavation methods, or EPB and slurry-type TBM's.

As these innovations have continued to be refined, projects that would be extremely difficult — or at least terribly disruptive — are now being built. (For all its negative publicity, imagine how Boston’s Big Dig would have been perceived if the Central Artery or other major thoroughfares were taken out of commission during construction.)

In this issue we highlight a pair of companies with long histories in the U.S. tunneling market, but which are also on the leading edge of the new wave of technology-based projects that are expanding the industry.

With roots dating back to the 1918, Moretrench Corp. is a specialty geotechnical contractor that provides support services for hard-rock and soft-ground tunnels — services like dewatering, freeze walls and jet grouting that enable shafts to be built or consolidate ground for tunneling or jacking. In the article “Geotechnical Solutions” (p. 14) Moretrench’s Paul Schmall and Kenneth Chadwick present an overview of the current geotechnical tools available.

The other article, “Allentown Industries” (p. 18), describes the merger of two companies — Allentown Equipment and Cellular Concrete LLC — that each have roots dating back to the early 20th century; Allentown Equipment was originally formed in 1911 while Cellular Concrete’s product line was created by the Mearl Corp., formed in the 1930s. Allentown is playing an important role in the expanded use of wet-mix shotcrete, which is gaining popularity because of its versatility.

Although construction techniques have changed since these companies were founded, they have been able to remain competitive by adapting to new technologies and diversifying their products and services.

North American Tunneling 2006

The North American Tunneling (NAT) Conference, the largest tunneling event in North America this year, is scheduled for June 10-15 at the Palmer House Hilton in Chicago. The theme of this year’s NAT is “Extreme Tunneling: Improving Progress, Cost, Performance and Safety.” Paper sessions cover a host of topics ranging from management, design and construction, and more than 50 exhibitors had signed on through early April.

Congratulations are in order for the program committee, including Tom Peyton, chair, and Ted Budd, vice chair, who were able to pull together the program despite a complete changeover in administration. As previously reported, NAT’s sponsor, the American Underground-Construction Association (AUA), was dissolved as a legal entity and reformed into the Underground Construction Association, a division of the Society for Mining, Metallurgy and Exploration (SME). The volunteer officers from AUA are still in place, but administrative functions, including managing NAT, have been assumed by SME.

As of early this year, many questioned whether NAT would even happen. Not only is it going on as planned, but it looks to pick up where it left off at NAT 2004 in Atlanta.

Regards,

James W. Rush
Editor
Microtunneling & Sliplining of Sewer and Storm Water Lines:
Meeting Your Most Demanding Challenges

Meyer Polycrrete Pipe Systems – An Ideal Solution for Your Demanding Microtunneling Applications
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- Compliance with ASME Standards
- Proven application record worldwide and in USA
Seattle to Vote on Viaduct Options

Seattle City Council members recently edged toward a public vote on replacing the Alaskan Way Viaduct, but with a significant question still looming — if voters opt for removing the viaduct and not replacing it, will the state still finance it? According to a recent story in the Seattle Post-Intelligencer, voters could face a decision on the November ballot. The state’s commitment to fund $2 billion of a replacement is considered key to any replacement moving ahead — whether that ultimately involves a tunnel option or a new viaduct structure. But some city council members and others are expressing support for giving voters the third choice of not replacing the viaduct at all and finding another way to move traffic through downtown.

State lawmakers have given the city the option of declaring a preference for a viaduct replacement or putting the choice to an advisory vote. The assumption has been voters would be given two choices on the ballot: a rebuilt, somewhat larger viaduct or a tunnel. Legislation authorizing the $2 billion doesn’t clearly say the money cannot be used to remove the viaduct without replacing it.

The City Council’s Transportation Committee recently began discussing an advisory ballot measure. Committee Chairperson Jan Drago said she expects the council will decide this spring whether to put the question to a city vote, and that in early August it would decide what options to include in the measure. The council was scheduled to discuss the three main options — the tunnel, a new viaduct and “no replacement” — on April 24, May 30 and June 19; an additional session may be set in May.

Drago said she also wants to hear more about a tunnel variation proposed by Allied Arts of Seattle, with a lid that could have trees or buildings on it. Councilmen Peter Steinbrueck and Nick Licata have said any vote should include the no-replacement option to give voters what Steinbrueck called “a real choice among the options.”

Steinbrueck said neither a tunnel nor a replacement viaduct “promotes trip reduction, nor provides a genuine transit alternative to the automobile for commuters and others using the corridor.” He backs the “surface” solution and the use of more transit to move people as a cheaper option with fewer effects from construction.

Contracting Practices Manual Being Revised

The Underground Construction Association (UCA) of the Society of Mining, Metallurgy & Engineering (SME) recently started developing a new and improved version of the 1974 Better Contracting for Underground Construction manual. The new manual will identify “best practices” for owners and other project participants, based upon contracting practices that have worked or not worked over the past 30 years. The primary focus is underground construction: Tunnels and shafts for highway/rail/water/waste-water and other uses.

The UCA steering committee seeks individuals interested in volunteering their time and expertise by reading drafts of specific chapters, providing comments and participating in consensus-building workshops. The committee hopes individuals who represent a broad spectrum of experience, background and geography will participate.


Each chapter will be 10 to 20 pages in length, with supplemental materials contained in an appendix. The review process will begin in May as individual chapters are produced. Reviewers will have two to four weeks to read a chapter and provide written comments to the steering committee. The first round of comments is expected to be due June 10 at the NAT conference in Chicago.

Interested individuals should e-mail edgerton@jacobssf.com, identifying which chapter(s) they commit to reviewing and providing a valid e-mail address where the draft chapters may be sent.
Microtunnel Chosen to Solve Flooding in Chester Brook, Mass.

A new microtunnel extending under Rt. 128 in Cambridge, Mass., was recently chosen as the best way to keep Prospect Hill stormwater from flooding Chester Brook and West Chester Brook, according to Colorado-based MWH, which was hired last year as a consultant by the city Engineering Department.

According to an article in Boston’s Daily News Tribune, MWH presented its analysis of an $8 million solution to Chester Brook flooding, presented in 2002 by Framingham-based Rizzo Associates. The $45,000 value-engineering project found the Rizzo solution would not work without a component to reduce runoff into West Chester Brook upstream, from Prospect Hill.

“This upper area is so critical, all the detailed analysis we’ve done focuses on this area,” said MWH engineer William Pisano.

The original plan would have funneled that water into the Hobbs Brook Basin, which is a drinking water source for the City of Cambridge. Liability issues prevented the connection, which would have gone through Massachusetts Highway Department drainage equipment running under Rt. 128.

City engineers had proposed converting two water mains that now run eastward into Waltham, which was included in a list of four alternative possible plans. MWH recommended a new solution — that the city build a new 42-in. drain and 54-in. diameter microtunnel under Rt. 128 to the Hobbs Brook Basin.

Pisano said if the upstream components work well enough, the city may save money on other stages of the project.

Charleston’s Daniel Island Sewer Extension Approved

The Charleston, W.Va., Water System board recently approved a $24.4 million contract to extend Charleston’s sewer tunnel system to Daniel Island, according to an article in The Post and Courier. The system will be designed to handle the 10 million gal of daily sewage that’s expected when the area is eventually built out. The water and sewer system’s Daniel Island treatment plant has a capacity of 500,000 gal per day, and Charleston Water System is seeking a permit to double that.

The long-term plan is to pipe the waste from Daniel Island, Cainhoy and Thomas Island under the Cooper River, through the sewer system on the Charleston peninsula, and under the Ashley River to the Plum Island treatment plant.
Options for Storrow Tunnel Project Being Investigated

According to a recent report on the CBS Boston affiliate, Massachusetts state officials are investigating options for another major roadway construction project. Transportation officials are examining four scenarios for fixing or replacing the 55-year-old tunnel on Storrow Drive, which some 100,000 commuters use on a daily basis.

The Storrow Tunnel has a slew of problems that need to be addressed, including a leaky roof and corroded steel beams. This year, the tunnel was given a zero rating under Federal Highway Administration criteria judging the lifespan of bridges and underpasses. Officials say the tunnel, with a leaky roof, corroded beams and falling concrete, has less than five useable years left.

Simply rebuilding the tunnel would take more than two years and cost more than $54 million. Eliminating the tunnel and raising the roadway to surface level would take an estimated 18 months and cost between $35 million and $42 million.

The third and fourth plans include rebuilding the existing tunnel and constructing a new, westbound tunnel under the Esplanade. Both plans would take about four years and could cost more than $100 million. The rerouting of traffic during the project will be a significant consideration, but officials have ruled out a plan to build a temporary road on the Esplanade.

Statements of qualifications are being sought by the Florida Department of Transportation (FDOT), District 6, as the first step in a nine-month process to select a business organization that will design, finance, build, operate and maintain the Port of Miami Tunnel. The project will link Interstate 395 and the MacArthur Causeway on Watson Island with Port of Miami facilities on Dodge Island. The Port is the area’s second-leading economic generator.

A request for qualifications (RFQ) was posted on the official project Web site www.portofmiamitunnel.com as of Feb. 17, and includes specifications and requirements for prospective bidders. A short-list of no more than four qualified bidders will be selected by FDOT in April. Those short-listed will receive the Request for Proposals in mid-June. Award of the project to the winning bidder is expected in December.

Responding to requests from potential bidders, FDOT extended the deadline to April 12 for submission of Statements of Qualifications as part of an addendum to the initial RFQ that was announced in February.

Included in the addendum are project specific revisions to the Department’s pre-qualification process for contractors and engineering firms, and adjustments to the previously published minimum financial criteria for construction and engineering firms. FDOT released a supplement to the Project Information Memorandum (PIM), which has been provided to help prospective bidders understand the project, as well as the state transportation agency’s approach to it. The PIM is not a binding document and information within it may change as aspects of the project become further refined.

A new round of geotechnical tests also began recently in the Government Cut channel site. Prospective bidders indicated they wanted more information before seeking the contract to design, build, finance, operate and maintain that project.

Data gathered will help reduce risks that might arise during the building process. Test results will be detailed in a series of geotechnical reports that will be posted on the project Web site.

The project will help maintain the competitiveness of the Port of Miami, Miami-Dade County’s second leading economic generator, by improving access for cargo and passenger vehicles and reducing congestion along downtown Miami streets. Spearheaded by FDOT, the project will be developed as a private/public partnership with a concessionaire to be selected by December 2006.

Port of Miami Tunnel Study
Public Affairs Program

The Miami Port Tunnel Project will link Interstate 395 and the MacArthur Causeway on Watson Island with Port of Miami facilities on Dodge Island.
Northeast Interceptor Sewer Takes ASCE and APWA Awards

The Northeast Interceptor Sewer (NEIS) has received recognition from the American Society of Civil Engineers (ASCE), Metro Los Angeles Branch, as its outstanding government civil engineering project for 2005. The award acknowledges NEIS for its innovation, achievement over adverse conditions and resultant improvement in the quality of public life.

In addition, the Southern California Chapter of the American Public Works Association (APWA) honored NEIS as one of the outstanding achievements in public works at its 2005 annual awards program.

At $162 million, NEIS represents the second largest construction contract ever awarded by the City of Los Angeles' Department of Public Works. The project upgrades L.A.'s aging sewer infrastructure and allows for future development while protecting the public's health from the dangers of sewage spills.

NEIS became operational three days ahead of the California Regional Water Quality Control Board's Cease and Desist deadline. Jacobs Associates provided multiple services during the planning, design and construction of NEIS.

Boston Officials Endorse Silver Line Tunnel

Transportation and business leaders in Boston recently announced a plan to connect the Silver Line bus service routes by constructing a mile-long tunnel under downtown Boston from the intersection of Tremont and Charles streets to South Station.

According to a recent story in the Boston Globe, the proposal was reached after the project was put on hold seven months ago because of community opposition to another tunnel proposal linking the two Silver Line surface routes. The plan, the third major proposal for completing the Silver Line, still needs federal approval.

A previous proposal called for a tunnel entrance in a different location, and another had buses traveling the downtown route on surface streets. The latest version calls for the tunnel to start at a portal at Tremont and Charles streets and connect the existing Silver Line routes.

Unlike the first tunnel proposed, the new route would avoid disrupting emergency vehicles around New England Medical Center. Massachusetts Bay Transportation Authority (MBTA) officials also said they believe the new tunnel would have minimal impact on groundwater levels around Bay Village, where stable ground water levels are necessary to preserve building foundations.

Construction of the tunnel would be done either by burrowing or by “cut-and-cover” methods, in which surface streets are excavated and then covered when the tunnel is complete. If all goes according to plan, construction could start around 2009 and finish by 2013 or 2014, officials said.
People

Mazhar to Head Brown & Caldwell Tunneling and Geotechnical Practice

Brown & Caldwell recently announced that Farrukh M. Mazhar has joined the company as a vice president and director of its tunneling and geotechnical practice. Mazhar has been in the industry for more than 37 years, specializing in large water conveyance, wastewater and combined sewer overflow systems. Based in Brown & Caldwell’s Chicago office, Mazhar is responsible for providing technical direction on Brown and Caldwell projects throughout the United States. He is currently working on two tunneling projects for utilities in Milwaukee and the Minneapolis-St. Paul area.

“Farrukh understands the complexities of large conveyance systems and has delivered results to a range of utilities nationwide,” Brown and Caldwell vice president Deb Harmon said. “He’s known for listening to client needs, building the most experienced team and working with the client to meet challenges. Having him on board is a major advantage for our clients nationwide.”

Mazhar’s other recent project work includes the New Croton Water Treatment Plant Tunnels and Aqueduct for the New York Department of Environmental Protection, the O’Hare South Airfield Drainage Project for the City of Chicago, the Borman Park Water Filtration Plant New Intake Tunnel for the Northwest Indiana Water Co., and several Midwest flood control and large diameter water conveyance tunnel projects for the U.S. Army Corps of Engineers.

Boyce Joins Jacobs as Senior Associate

Jacobs Associates recently announced that Glenn Boyce, P.E., Ph.D., joined the firm as a senior associate. Boyce has more than 23 years of experience in tunnel and geotechnical engineering. His extensive career covers the fields of water, wastewater, power, highways and transit systems.

Boyce earned his Ph.D. in geotechnical engineering from the University of California, Berkeley, and attended Drexel University for both his master’s degree in geotechnical engineering and bachelor’s degree in civil engineering.

Whether as engineer, lead engineer, project manager or technical reviewer, Boyce has undertaken practically all aspects of the engineering process: preliminary and final design, alignment and layout, geometrics, laboratory testing, environmental assessment and cost estimating and analysis.

In addition to a tremendous practical background, Boyce also has a wealth of scholarly credentials. His more than 50 publications span a range of topics, including tunneling, microtunneling, geotechnical exploration, social costing, risk acoustic emissions and hydraulic fracturing.

The Colorado School of Mines and North American Society for Trenchless Technology (NASTT) both feature Boyce as an instructor for their microtunneling short courses. A former member and chairman of NASTT, Boyce remains active in many professional organizations, including the American Society of Civil Engineers (ASCE).
During the past several columns, Dr. Mole has been promoting a more proactive approach to value engineering for tunneling projects. In general, the primary thrust of those discussions has been to emphasize cooperation and flexibility with respect to the design of temporary facilities and the selection of construction means and methods while at the same time providing a clear definition of what is required to produce the finished facility. This is especially important since for most tunneling projects construction of the hole in the ground represents anywhere from two-thirds to three-quarters of the cost of the work as compared to installation of the final lining.

In the October 2005 edition of this column, Dr. Mole published a specification titled “Construction Engineering” that attempted to make “improvements” to a typical VE specification and made it available for viewing at www.tunnelingonline.com/construction_engineering_specifications.htm. Several persons downloaded the specification and provided me with their comments, including: Chris Laughton, Mike McBride, Ken Smith, Mike Gilbert, Bill Edgerton, John Stolz, Hugh Caspe, Mike Robison, Heiner Sander, Pliny Jewell, Jon Kaneshiro, Dave Jurich and Jim Peregoy. I also discussed the specification with Bob Pond, who, as usual, provided excellent feedback. Thanks to all.

Since many who read this column have not yet read the specification, it was intended to be user-friendly for the contractor insofar as the contractor hired a registered engineer to perform design services for the temporary facilities, thereby accepting risk for that design and providing the contractor with a return on investment consisting of less cost, reduced schedule, greater flexibility, and improved safety — largely along the lines of what would happen on a typical design-build procurement. The construction engineering specification also made allowance for time in the schedule to accomplish the above by utilizing a Dual Notice to Proceed (NTP), and for the possibility of drilling additional test borings, if required. All of the above was based on a rather formal submittal procedure that required a good deal of upfront activity and commitment.

Several of the reviewers liked the basic concept of a construction engineering specification, but noted problems with the proposed implementation strategy. For instance, many reviewers felt that the preparation of construction engineering proposals would lengthen the construction schedule even though the Dual NTP was specifically intended to provide time for that activity. Most reviewers also thought that the Dual NTP concept would be difficult to manage for most owners, and that contractors would not want to be bothered with either the cost or the risk associated with something going wrong during a “complicated” NTP arrangement.

Most reviewers also did not want to even think about the possibility of performing additional test borings after NTP even if those borings would be beneficial for planning and constructing the facility. Many contractors that Dr. Mole has worked with over the years seem to be continuously surprised about how defensive designers are about every word in the contract; even with respect to the temporary structures and/or the means and methods of construction. Once the contract is produced, however, those words are cast in stone, and any change to the contract means that the designer somehow must have “made a mistake.” To be honest, that attitude came across loud and clear in the comments that were received about the proposed construction engineering specification. As Bob Pond has said in this column, owners and designers can be quick to erect the fortress walls as soon as the big, bad contractor appears on the horizon.

It is quite clear from an objective assessment of the reviewer’s comments that the construction engineering specification as proposed by Dr. Mole is not about to set the tunneling world on fire, but the comments themselves provided an enormous amount of food for thought. It has been more than 30 years since the “Better Contracting for Underground Construction” study was published. The stated purpose of that study was to improve contracting practices for tunneling projects with respect to the following primary objectives:

- To help the owner obtain a completed project at lower cost while, at the same time, providing a “just” profit for the contractor.
- To foster a cooperative atmosphere between the owner and the contractor.
- To stimulate the use of advanced technologies and innovative construction techniques.
- To provide for the equitable sharing of risks, especially those risks that are not “identifiable.”

Since that time we have introduced the concept of Geotechnical Baseline Reports in an effort to define the “undelinable,” and have begun to apply design/build procurement concepts to tunneling. All things considered, however, Dr. Mole hasn’t seen a lot of progress. We still see tunnel contracts that disclaim subsurface information, geotechnical data reports that are based on grossly inadequate and/or inaccurate test results, and geotechnical baseline reports that are little more than “CYA” documents for the geotechnical engineer.

Many first-time owners of tunneling projects still use contract formats that are better suited to above-ground construction and the litigious atmosphere surrounding many tunneling projects does not seem to be abating with contractors now targeting designers directly for providing “negligent” design-related input to the contract document. Somehow, despite all of the above, we must continue to work diligently toward fulfilling the primary objectives of the 1974 Better Contracting Study. Dr. Mole understands that preliminary results of an updated version of this study will be discussed at a workshop on June 10, 2006, in conjunction with the NAT conference in Chicago. We can only hope that this new study will help us make our industry more cost-efficient for owners and more predictable for contractors.

Gary Brierley is president of Brierley Associates, Denver.
Work has begun on a £180 million extension of a major city light railway route that will play a big part in the 2012 Olympics in London. A 540-ton TBM has been put in place for the 1.5-mile Woolwich Arsenal extension to London’s Docklands Light Railway (DLR).

Tunneling will begin in April and take 15 months to complete, during which time the boring machine will remove over 136,000 cu yds of material — enough to fill 40 Olympic-sized swimming pools. The extension, which will open in 2009, is part of Transport for London’s five-year £10 billion investment program. The extension will serve the Royal Artillery Barracks in Woolwich, which will hold the shooting events in the 2012 Olympics.

The extension is being designed and constructed by the AMEC Co., which was also responsible for the recently opened extension of the DLR to London City Airport. DLR director Jonathan Fox said: “It’s great news to see work starting on this further extension to the DLR, which will serve Woolwich town center from 2009. I’m sure this new extension and the Woolwich Arsenal DLR station will be a tremendous asset for London and the local community, continuing DLR’s excellent record in supporting and generating London’s development and growth.”

Close behind London and Moscow, Madrid’s metro system is the third largest in Europe. Spain is currently one of the world’s busiest arenas for powerful TBM giants, as 18 of Herrenknecht’s large-diameter tunneling systems are part of regional and trans-regional traffic tunneling projects.

In November 2005, what is currently the world’s largest TBM (with an excavation diameter of 15.2 m) was launched in Madrid. The Herrenknecht S-300 Earth Pressure Balance Shield (EPB) is set to drive the 2.3-mile underground freeway north tunnel of the “M-30” in the middle of the capital. With 125,268 kNm the machine has the highest torque ever installed on a TBM. In order to maintain control of the large excavation diameter in high friction ground conditions Herrenknecht engineers have come up with a specially developed and unique cutting wheel concept for this project. It consists of an inner cutting wheel with a diameter of 23 ft and an outer cutting wheel, with a 50-ft diameter, working on the same plane.

Week by week the giant boring machine knows to convince with increasing performance rates. By mid-February 2006 the contractors’ construction team (Acciona Infraestructuras S.A., Ferrovial-Agroman S.A.) already constructed 1,968 ft of tunnel (300 rings) with the help of the giant. The best daily performance was 72 ft (11 rings).

Another high-tech boring machine (S-299) from Schwanau bored through clayey and sandy ground of the Spanish capital. The EPB-Shield (ø 30.7 ft) already reached its target on Dec. 7, 2005 after an excavation period of only six months and 1.6 miles of completed tunnel. The new tunnel section in downtown Madrid was driven with best weekly performances of 645 ft (131 rings).

Since its launch the “twin machine” (S-302) has been pushing ahead. On its way through lime, sand and loam the machine advances with the 3,600 kW cutting wheel achieving best performances of 157.5 ft per day (32 rings) and up to 802 ft per week (160 rings). These top performances have so far been unparalleled compared with advance rates of TBMs with similar parameters in terms of dimension and power.

Overall, eight EPB Shields from Schwanau pave the way for new metro lines deep under the Spanish capital. Week by week the machines construct up to 3,280 ft of tunnel in the underground; this indicates the rapid development of the metro system. The first 32 miles of the system was completed between 1999 and 2003, while nearly another 45 miles are scheduled for completion by 2007.
Second Tube Tunnel Planned Under Bosphorous

The first steps have been taken for the second tube tunnel project running under the Bosphorus in Istanbul. A related bill for the implementation of the Transportation Ministry’s tunnel construction project, which will enable the transportation of motor vehicles between the two continents in Istanbul, after the Marmaray project, was recently ratified by the Public Works and Construction Commission.

Transportation Ministry Assistant Adviser Mehmet Habib Soluk, briefing about the project, said it will be constructed without the use of any state resources and will be completed based on the build-operate-transfer model, without a Treasury guarantee.

Soluk informed that only passenger motor vehicles will be able to use the 3.1-mile, eight-lane tunnel, which will help to relieve Istanbul’s growing traffic problem by allowing 70,000 vehicles a day to pass through it.

The ruling Justice and Development Party (AKP) Deputy Zeynep Karahan Uslu said the reason for introducing the bill is to prevent the troubles that were experienced with the Marmaray project from happening with this project.

Pedestrian Tunnel Planned for Singapore Railway

Work on a quarter-mile tunnel that will connect Singapore’s Seremban Railway Station to the Terminal One bus complex is expected to begin in June and completed by March 2007. The tunnel was designed to reduce the high risk of accidents faced by pedestrians crossing the busy Jalan Sungai Ujong.

"Thousands of pedestrians use the zebra crossing on Jalan Sungai Ujong daily, placing their lives in danger due to the high volume of traffic on the stretch," said Seremban Municipal Council (MPS) president Abdul Halim Latif. "More than 20,000 commuters who work in Kuala Lumpur use the zebra crossing daily to get from the railway station to the bus complex. It is very hard to cross the busy junction during peak hours."

Initially, the council planned to build pedestrian bridges along the stretch, but the idea was scrapped after a survey showed that many such bridges in Seremban were redundant. Once completed, the tunnel would be lit 24 hours and closed circuit TV (CCTV) cameras will also be installed.

Lane Cove Tunnel Competition Subject to Change

Australia’s Roads and Traffic Authority recently learned that completion of the Lane Cove Tunnel, which was initially planned for September, might not be ready for its scheduled May opening. The AU$ 1.1 billion, 2.1-mile twin tunnels will link the Gore Hill Freeway with the M2 Motorway at North Ryde. It is part of the Sydney Orbital Motorway.

Tunnel operators were aiming for a likely earlier opening, but were not prepared to commit to an opening date because “actual completion depends on weather and progress.” New documents have surfaced as part of further calls for papers by State Parliament. The documents also show that the Hills Motorway company, which runs the M2, has warned the Lane Cove Tunnel company it considers the lane arrangements between the two privately owned expressways will create hazards for merging and exiting traffic and lead to illegal maneuvers as motorists try to leave the M2 for Epping Road.

The Australian government expressed concerns when told of a possible early opening — in mid-December — because this would mean the associated road and lane closures in Epping Road would take place before the state election next March. However, the Government’s concern stopped short of requesting a delay. David Saxelby, chief executive of Theiss John Holland (the project’s construction company), said it now aimed to open the tunnel in mid-December. He stressed the date, which did not take account of any further delays, was not a firm one.

Ian Hunt, chief executive of the tunnel operator, denied he had been asked to delay the project and said it was too early to know when the tunnel would open, but Hunt e-mailed the RTA requesting a meeting in early March to discuss the insurance cover for the tunnel once it was opened.

A spokesman for Hunt said the construction company has a target completion date of September 2006, but this does not include any contingency or allowance for construction delays due to complexity of works such as the Pacific Highway exit ramp and the Reserve Road Bridge, winter weather or industrial relations, etc. This referred to a construction completion date, not a project opening date.

Asia’s Longest Land Tunnel Railway Now in Operation

The Wushaoling Tunnel Railway, the longest of its kind in Asia, recently opened to traffic in China’s northwestern Gansu Province. The 13-mile tunnel railway, which is more than 1.5 miles above sea level, is a key project for the Asia-Europe Land Bridge’s 2,268-mile section from Lianyungang in East China to Urumqi in Northwest China.

Designed to allow speeds of 99 mph, the tunnel railway has shortened the distance between Dacaigou and Longgou, part of the long section, by 19 miles. The right tunnel railway line (the west to east direction) opened in early April and the left line (in the opposite direction) is planned to open in October. They will provide a significant boost for transportation between China’s east and west regions, according to a top Chinese railway official.

The operation of the tunnel railway will also help ease the cargo and passenger transportation pressure on the Asia-Europe Land Bridge, the cheapest and fastest Asia-Europe land rail route, which starts from Lianyungang and goes westward to its terminal at the Port of Rotterdam in the Netherlands, the official said.
Soft ground tunneling arguably remains the most challenging of underground construction operations. Until the early 1990s, the large diameter, open-face “digger shield” or “conventional shield” was still the leading method to install larger diameter tunnels in the United States, frequently with extensive dewatering and canopy grouting. Today, soft ground tunneling work is almost exclusively performed by pressurized face methods or by the New Austrian Tunneling Method (NATM), techniques at opposite ends of the ground support spectrum and requiring vastly different ground support effort.

The geotechnical methods that are being used by Moretrench Corp. and other specialty contractors in support of tunneling and tunnel-related operations are as varied as the potential subsurface conditions. The more complex and extensive the tunneling operation and the more challenging the subsurface conditions, the more likely it is that multiple geotechnical techniques will be required. The New York City Metropolitan Transit Authority’s (MTA) East Side Access Contract CQ.028 (bid in late March) is a case in point.

The project includes a tunnel crossing with a recommended construction scheme consisting of a 125-ft long, 60-ft wide and 40-ft high NATM tunnel, a frozen ground canopy arch for groundwater control and temporary ground support, compensation grouting to protect the buried subway from settlement and a mechanism for heave control to limit the potential effects of freeze-generated ground heave on the existing structures.

In recent years a number of tunneling or tunnel-related projects, both large and small, owe their success to careful evaluation of the prevailing conditions and the experience of the project engineering team in designing and constructing to minimize surface impacts or reacting quickly to an unexpected condition or event.

More to the Project Than the Tunnel

Pressurized face or earth pressure balance tunnel machines provide improved earth support during tunneling and eliminate the need for dewatering and ground improvement. However, even with pressurized face techniques, ground improvement and/or dewatering may be required for the excavation of access shafts, launching or retrieving the tunneling machine, starter tunnels and cross passages. A number of geotechnical techniques are in current use.
Jet grouting is commonly used to install perimeter walls for stabilizing shaft breakouts and break-ins. Unlike construction techniques such as slurry walls, secant pile walls and soil mixed walls, which are limited to the construction of vertical walls, jet grouting can also be used for the construction of horizontal bottom seals to control groundwater inflow into a “bathtub” excavation that has no naturally impervious bottom. Jet grouting can also be used for the installation of an arch or canopy over a tunnel or completing closure around utilities or other obstructions that create “gaps” in otherwise continuous barrier walls. Thin, non-structural, jet-creted diaphragm walls installed outside of a structural element can form an effective, economical groundwater barrier. On the Lenox Avenue Subway line rehabilitation project in New York City, jet grouting provided a groundwater barrier at a difficult sand/silt interface to permit replacement of the subway invert without ground loss due to water running across the sand/silt interface.

Jet grouting can provide a high compressive strength soil-cement product in most soils. However, the technique does have certain limitations. The presence of boulders or obstructions can block the jetting penetration and the “shadow effect” can result in incomplete coverage and ungrouted inclusions. Under significant water pressure, multiple rows of interconnected jet grout columns must be used to compensate for the possibility of ungrouted inclusions. And although jet grouting can theoretically be accomplished to any depth, there is a practical depth limitation (nominally 60 ft) beyond which verticity is difficult to maintain and designed overlap of the columns therefore becomes more difficult to achieve.

Ground freezing can be effective in essentially all soil types and provides a similar, though temporary, end product to jet grouting, i.e. high compressive strength ground. The fields of application, however, differ for jet grouting and ground freezing. Freezing is well suited to deep applications, difficult ground that may not be amenable to jetting or disturbed ground that may be sensitive to mechanical action. The technique is cost-effective where both groundwater cut-off and excavation support are required.

It is recognized as an important tool for deep access or vent shaft excavation. In fact, shafts are the most common application for ground freezing. To date, this technique has been used on 10 shafts for New York’s City Water Tunnel No. 3 (TBM, October 2005) and has been applied successfully on numerous shaft construction projects across the United States for both tunneling and non-tunneling projects.

In emergency tunneling situations such as where access to the cutterhead may be necessary or when the freeze is required to be maintained for only a short time, liquid nitrogen, which promotes more rapid freeze formation, can be used as the freezing medium in lieu of brine. When a jacked pipe TBM encountered unanticipated loose, sandy embankment fill and became mired 25 ft beneath New Jersey’s Garden State Parkway, and within 35 ft of the receiving pit, an urgent response was needed to avoid damage to the Parkway and retrieve the TBM. Liquid nitrogen freezing was the only viable solution in the time frame. Horizontal drilling and freezing formed a canopy of fully stabilized soil over the crown of the TBM within several days. Advancement of the tunnel continued immediately thereafter.

Given that TBMs are most efficient when designed to operate in one relatively consistent ground condition, the presence of an isolated section of soft ground, for example, along the alignment of a hard rock tunnel can bring the tunneling operation to a screeching halt. George Fox has been credited with saying that “[Conditions in] 200 ft of tunnel can make or break a project.” Jet grouting or ground freezing can be utilized to “homogenize” mixed ground conditions to permit the uninterrupted run of the TBM.

It has also been used to create a homogeneous horizon for microtunneling through mixed face conditions and to provide an improved bearing material for microtunnels advanced through poor soils. On the Central Artery/Tunnel project in Boston, mass freezing was used to stabilize a 39-ft high face consisting of saturated fill, peat and Boston Blue Clay for jacking of three concrete boxes, 150 to 350 ft long, beneath Amtrak right of way.

Ground freezing, like jet grouting, has certain limitations. The operation and maintenance associated with the typical ground freezing program adds an additional cost component to the overall project. Under rapidly moving groundwater conditions, difficulties in achieving closure of the freeze can be encountered, although this can be overcome with grouting techniques. In certain soils, heave can also occur due to frost action.

Dewatering, since it indisputably changes the characteristics of the ground, cannot be disregarded as a geotechnical technique and is often essential in the construction of tunnel project ancillary structures. In many cases, the best solution to a ground control situation is a combination of dewatering and a ground improvement technique. Where groundwater lowering has potentially adverse off-site effects, groundwater treatment technologies applied to artificial recharge have totally changed the complexion of this work. Re-injection is now done effectively with minimal maintenance. The Central Artery/Tunnel in Boston, the Orme Street Combined Trunk Relief Sewer in Atlanta and the Copenhagen Metro projects are success stories of recharging of the ground to protect adjacent sensitive structures.

During tunneling in urban environments, there is often a need to protect overlying structures from tunneling-induced ground movement.
Moretrench: 
75 years of Achievement ... and Counting

In 2006, Moretrench Corp. celebrates its 75th year since the company was officially founded in 1931. However, the original company first opened its doors for business in 1918 when founder Thomas Moore began manufacturing and leasing his proprietary conveying excavator from premises in Rockaway, N.J.

In 1925, the fledgling Moore Trench Machine Co. leased a machine to a sewer contractor in Hackensack, N.J. When the contractor became bogged down in quicksand, Moore assumed the contract and designed, built and installed the first practical wellpoint dewatering system in the United States to stabilize the quicksand. This marked the beginning of what was to become a thriving addition to his core business.

Building on his initial success, Moore continued to develop and improve his wellpoint system, finding a growing local market. By 1931, demand for his dewatering products was so great that he decided to make this his sole focus, incorporating as Moretrench Corp. Some 10 years later, Moore established a separate company, American Dewatering Corp., to subcontract the entire pumping operation. By 1944, Moretrench wellpoint systems had been used on 18 major subway projects in Brooklyn, Queens and Manhattan.

After 30 years of operation, Moretrench and American Dewatering merged in 1972 and Moretrench American Corp., the forerunner of modern-day Moretrench, was born.

Full-Service Company

During the mid-1970s, mass transit systems were being constructed across the United States. Moretrench worked coast to coast, dewatering station excavations, as well as running tunnels in Washington, D.C., Boston, Buffalo, Baltimore, Atlanta, New York and San Francisco. At the same time, the parent company created a new subsidiary, freezeWall, to pursue U.S. ground freezing opportunities.

To complement its by then well-accepted technologies, the company subsequently formed Ground/Water Treatment & Technology to cater to the emerging groundwater remediation market, and Moretrench Geotec, offering a wide range of geotechnical services for underpinning, excavation support and soil stabilization.

Path to Success

Following in Thomas Moore’s tradition of innovation, Moretrench’s path has been punctuated by a number of significant company milestones. Construction of Lock & Dam 26, just above the confluence of the Missouri and Mississippi rivers near St. Louis, involved what was by any measure one of the most ambitious dewatering projects ever to be accomplished in the United States.

Subgrades for the three large excavations were kept dry 86 ft below high river stage while pumping as much as 100,000 gpm from multi-stage wellpoint systems. More recently, mass ground freezing aided jacking of three box tunnels for Boston’s Big Dig.

Moretrench returned to the World Trade Center in 2001 (after dewatering the area adjacent to PATH tubes for foundation excavation in 1968) and lowered the water level outside the damaged foundation to help stabilize the slurry walls as debris removal progressed.

While Moretrench has certainly changed over the years, one element has remained the same. “We are first and foremost, problem solvers,” says CEO John Donohoe. “We are committed to finding the right solution for every client ... and we look forward to doing that for many years to come.”

Stand-up Time Is Not a Thing of the Past

When used in soft ground, NATM tunneling requires the soils to be cohesive (or improved) in order to reduce the risk of ground loss and maintain stability. Adequate dewatering is very critical because of the effects of water on fine grained soils and the fact that the operation relies on a relatively long “stand-up” time for the soil. Flowing ground or ground with short stand-up time is not amenable to NATM tunneling without ground improvement and/or dewatering.

Permeation grouting has been used extensively in conjunction with open face digger shield tunneling to increase the stand-up time of soils at the tunnel.
The plan and profile for New Jersey’s Garden State Parkway Tunnel face to allow mining to take place without significant ground loss at the face or to create an arch of stabilized soil above the tunnel alignment in order to protect overlying structures from settlement. As NATM methods are coming into more common practice in the United States, their application is being stretched to more varied ground conditions, often requiring the soil stand-up time to be increased by ground improvement techniques such as permeation grouting.

Vertical drilling for grout injection is, of course, the more economical approach. However, where this is not possible due to below ground obstructions or surface access restrictions, horizontal drilling can be utilized. Long bore horizontal directional drilling in conjunction with permeation grouting for NATM tunneling was successfully accomplished on a portion of Washington, D.C.’s subway system mined beneath a historic cemetery through challenging subsurface conditions (TBM, April 2000). Shorter “barrel vault” pipe spiles were grouted in place with ultrafine cement in combination with extensive dewatering to facilitate NATM tunneling on Seattle’s Beacon Hill Project. A jet grout canopy was also installed at Beacon Hill to provide overhead support for mining of the station platform.

The biggest concern with permeation grouting, similar to jet grouting, remains its use in situations where groundwater control is required, but the ground may not be 100 percent amenable to permeation. Where the greatest assurance of groundwater cut-off and ground support are required, ground freezing can be utilized in conjunction with NATM tunneling and was accomplished successfully on the Russia Wharf Project on the Central Artery.

As tunneling methods have advanced, so has the range of geotechnical methods applicable to tunneling and tunnel-related activities. The appropriate geotechnical program can positively impact scheduling and cost. However, these are highly specialized techniques, and the desired positive impact is contingent on the quality of the design and the execution of the work. The services of an experienced geotechnical contractor is therefore vital.

Paul C. Schmall is vice president, and Kenneth R. Chadwick is chief engineer for the geotechnical division of Moretrench Corp., Rockaway, N.J.
Working on underground projects is no place for beginners. Challenging and changing ground conditions, surface structures and foundations, and a maze of existing (and sometimes unknown) utilities can prove to be expensive lessons for the uninitiated.

So when undertaking an underground project, having an experienced partner can be a valuable asset. It is with that in mind that Allentown Industries was created.

Allentown Industries, formed in 2004 with the merger of Cellular Concrete LLC and Allentown Equipment, draws upon nearly 150 years of combined experience in the field to offer a broad range of solutions to clients across multiple disciplines worldwide.

“The biggest asset of Allentown Industries is its tremendous knowledge,” said George Yoggy, chairman of Allentown Industries. “With more than 90 years in the business, Allentown Equipment has a huge store of information — it’s like a Fort Knox of shotcrete applications. And with Cellular Concrete, we have a similar base of experience.”

Allentown Equipment, formed in 1911 as The Cement Gun Co., is a leading designer and manufacturer of wet- and dry-mix shotcrete equipment and accessories. Cellular Concrete, with roots dating back to the 1930s, is a world leader in the manufacture and supply of foam concentrates for geotechnical, construction and insulating applications. The company also was recently appointed the exclusive distributor of Fibercon steel fibers for the North American underground and geotech market.

“Allentown Industries is unique in that both companies — Allentown Equipment and Cellular Concrete — were well respected in the field before the merger,” said Bob Freeman, general manager for Cellular Concrete. “And for the underground, they offer complementary products and services.”

Cellular Concrete LLC was set up by investors (Cellular Concrete LLC Investment Group) in 1999 for the purpose of purchasing the Mearlcrete brand and associated products that were being divested from chemical manufacturer Engelhard Corp. Meanwhile, Allentown Equipment, which had been acquired by the concrete additive company Master Builders, was also being divested when Master Builders was acquired by chemical giant Degussa. Seeing an opportunity to acquire a valuable brand that fit in with its existing business, the investment group acquired Allentown Equipment in 2004 and established Allentown Industries as the parent company overseeing Allentown Equipment and Cellular Concrete LLC.

Today, the two companies operate separately yet share the same facilities and work closely with one another. “We are one in the same company. We just have specialists that cater to the different needs of the clients,” said Patrick Bridger, general manager of Allentown Equipment.

Allentown Equipment

The history of Allentown Equipment dates back to the inception of the shotcrete industry itself. Shotcrete, or gunite as it was originally called, was developed in the early 1900s by naturalist Dr. Carl Akeley as a means of creating life-like models of animals for his taxidermy work. The patents for the equipment and method were granted in 1909, and it was introduced to the construction industry at the Cement Show in New York in 1910. In 1911, The Cement Gun Co. acquired the rights to sell the equipment and commercialize the technology.

The process consists of conveying dry material via compressed air to a gun (hence the term “gunite”) where water is introduced at the nozzle and the material “shot” at the desired surface.

The benefits of the new technology were quickly realized. In fact, one of the first projects to utilize the new...
technology was to encase support elements in New York’s Grand Central Terminal to protect them from fire and corrosion. It also became popular in new building construction, bridges, reservoirs, dams, tunnels and high temperature applications.

As The Cement Gun Co. grew, it began to sell equipment and license the process to contractors across the country and internationally. The licensees were then given the permission to use the proprietary term “Gunite.”

Several years later, the wet-mix method of shotcrete — which utilizes premixed concrete that is then pumped to a nozzle where air is added — was developed. The term “shotcrete” was coined to include both wet-mix and dry-mix spray-applied concrete. It was at this time that the name Allentown was adopted.

The development of wet-mix shotcrete has had important ramifications for the construction industry — particularly with the improvements in concrete technology that occurred in the 1980s and 1990s. The development of the rotary-style gun in the 1950s also expanded the scope of shotcrete as a construction and ground support process.

“Advancements in admixtures, steel fibers and equipment have increased the versatility of shotcrete and have enabled it to be used in a wider variety of applications,” Yoggy said. “For underground applications in the United States, shotcrete is particularly useful where you have transit projects in which new construction intermingles with existing structures. There are oftentimes intricate transitions, and the use of shotcrete for support is much more efficient than forming and pouring.”

The Future of Shotcrete

The market for shotcrete in tunneling is growing in the United States, although it still lags behind other places in the world. Yoggy said the U.S. underground shotcrete market is smaller than either Austria or Switzerland, but recent projects have showcased the unique abilities of shotcrete and its potential for the underground.

The Exchange Place Station rehabilitation project in Jersey City, N.J., is one example of the benefits of shotcrete. The station, originally built in 1908, served as a gateway to Manhattan via the trans-Hudson tubes that were flooded in the wake of the 2001 terrorist attacks on New York. With the station out of service while the tunnels were being repaired, the Port Authority of New York and New Jersey took advantage of the downtime to modernize the facility.

Due to complex geometry and a tight timetable — the station had to be online as soon as the tunnels were back in service — shotcrete was utilized as a key element of the design. The design called for shotcrete as initial support, as well as serving as the final liner. Traditionally, designers had considered shotcrete primarily as a temporary support that would be cast over.

The use of shotcrete shaved valuable time off the schedule compared to using concrete forms — up to six months, according to one consultant. The use of advanced admixtures — accelerators, stabilizers and superplasticizers that allow for concrete to be pumped long distances, improve workability and extend pot life — also played a key role in the successful completion of the project.

“The Exchange Place Station project is an outstanding example worldwide in terms of value and advantage of using shotcrete as a final lining because of the logistics and extreme geometry,” Yoggy said.

The equipment is also playing a key role in the effectiveness of shotcrete. Allentown Equipment’s latest wet-mix application products feature pulsation reduction technology that is easier for the nozzleman to operate and provides a more consistent final product.

“With some pumps, you have instances of hesitation in which concrete is not flowing through the nozzle,” Bridger said. “If you’re using this with an accelerator, for example, you can have areas where pure accelerator

While the market for shotcrete in tunneling still lags around the world, it is growing substantially in the United States. Recent projects have showcased shotcrete’s unique abilities and its potential for the underground.
is applied to the substrate, resulting in some inconsistency. But with the pulsation reduction systems, you can achieve better in-place shotcrete."

Allentown Equipment is also involved in training shotcrete nozzlemen. There is a test facility onsite that can be used for training and certification, and both Yoggy and Bridger are ACI-certified examiners. Bridger credits customer service, including longtime employees like service manager Greg Miller and parts manager Mark Ciccone, as a big part of the company’s success.

Bridger says that continued training in addition to education through ACI and the American Shotcrete Association will help to grow the industry. "Equipment and admixture technology are improving, but we need to continue to increase awareness, and that will drive the industry," he said. "This is a proven technology, but there are still a lot of people who don’t know about or understand its benefits."

Cellular Concrete LLC

The roots of Cellular Concrete date back to the 1930s with the formation of the Mearl Corp. One of the company’s first products was pearlescent paint, and it soon began to find uses for the foam byproduct that resulted from fish scales used in the production process.

Originally, the company developed a fire fighting foam that was utilized in World War II, and later developed Mearcrete, a lightweight concrete product using foam cells in place of traditional aggregate.

Cellular Concrete LLC has kept the Mearcrete brand name, as well as Geofoam, a low-density cellular concrete used for geotechnical and tunnel construction. These products are commonly used for tunnel backfill and annular fill; replacement for unstable soils; load-reducing engineered fill over underground structures; fill for abandoned mines, underground tanks and pipelines; bridge approach and landslip repair fills; and impact absorption.

Other markets include poured insulated decks, acoustic floor fills, slab on grade, underground pipe insulation and low-cost housing systems.

A project completed for the Portland Tri-County Metropolitan Transportation District demonstrated how cellular concrete can be beneficial compared to conventional formulations. Using a low-density grout containing cement, Geofoam foaming agent and fly ash reduced contact grouting cost by $600,000 for two 21-ft diameter, 15,000-lf transit tunnels, Freeman said. Use of the grout originally planned — a cement and fly ash mixture — would have cost $1 million in cement alone.

In addition to the length and size of the tunnels, the alignment passed through weathered, highly fractured basalt, which would require even more grout than usual to fill the voids and fissures.

The contractor used the foaming agent to decrease the amount of cement needed. Once the optimal formulation was agreed upon, the cement and fly ash were mixed in batch plants outside either portal and trucked to 6 cu yd surge tanks in the tunnels. Foam was added just before the grout was pumped through holes drilled in the 12-in. reinforced concrete lining.

Grouting lasted for 140 days with crews using nearly 13,000 cu yd of grout — an average of 11 cu ft per foot of tunnel. Core samples showed that the material was uniform and had bonded to the liner as well as penetrated into surrounding voids.

"Whether it’s a drill-blast tunnel or a TBM tunnel, there’s going to be a need for backfill, and Cellular Concrete can provide the right material for the job," Freeman said.

Traditionally, shotcrete and cellular concrete were used for projects only if there were unique circumstances or when it was presented as part of a value engineering proposal offered by the contractor. Increasingly, however, they are being specified by designers at the beginning.

With an ever-increasing need to repair and build new underground infrastructure, Allentown Industries is well positioned within the marketplace to continue to build on its century and a half of experience.

James W. Rush is editor of TBM: Tunnel Business Magazine.
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International Focus: Germany

By Alfred Haack

Germany has a long and rich tradition in tunneling. The oldest railway tunnels, located on the line between Cologne and Aachen, were opened to traffic in 1841. Work on the mile-long Königsdorf Tunnel started in 1837 and in the decades that followed, tunneling blossomed in Germany.

By 1880, some 300 tunnels with a total length of 70.8 miles were in operation. Around the turn of the 20th century, work began on urban commuter lines in major metropolitan areas including Berlin and Hamburg.

In 1980, major tunneling activity resumed with the commencement of high-speed lines for the Deutsche Bahn between Hannover and Würzburg, as well as Mannheim and Stuttgart. Altogether, 87 two-track tunnels with a total length of 93.2 miles were then built.

Overall, the German tunneling market has remained strong over the last 25 years. Periods of peaks and valleys in awarding new contracts have caused concern, due to the challenge of retaining skilled engineers and laborers, but the future looks promising.

According to recent statistics, a total length of 295 miles of new tunnel projects in Germany is expected within the next 10 to 15 years. This total is expected to include 90 miles of road tunnels, 155 miles of railway tunnels and 53 miles of subway tunnels.

Recent Progress

Several major projects have been completed and inaugurated during the last five years, including traffic tunnels in the central area of Berlin. At a length of 2.3 miles and an outside diameter of 32 ft, the tunnels were a bundling of four shield-driven railway tunnels, as well as one open-cut metro and one open-cut highway tunnel, all six undercrossings of the river Spree, the green of Tiergarten and the navigable Landwehrkanal (canal) in the future governmental area.

Recent Progress

According to recent statistics, Germany is expected to undertake approximately 295 miles of new tunnel projects within the next 10 to 15 years. Above, the 5.8 mile, double-tube Katzenberg Tunnel is being constructed for a high-speed railway line between Karlsruhe and Basel.

Under Construction

Railway Tunnels

A high-speed railway line (300 km/h) between Karlsruhe and Basel partly upgraded and partly replaced, integrating a major TBM-driven tunnel project, the Katzenberg Tunnel with a length of 5.8 miles and likely a second one, the 3.7-mile Rastatter Tunnel. Each tunnel consists of two parallel single tubes with about a 34.5 ft excavated diameter. Inauguration is planned for 2011 to improve the traffic connections between Northern and Southern Europe via Lötschberg and Gotthard base tunnels in Switzerland.

Deutsche Bahn project Stuttgart 21 involves putting the above-ground main
station underground. Besides the new underground main station, this project involves nearly 33 miles of single/double track tunnels; intensive design work was started in 1997. First construction started during 1998. After an intermediate slowdown, the project is reactivated. The entire project will be finished in about 10 years.

Motorway Tunnels

A most remarkable recent project is the fourth Elbe River tunnel in Hamburg, which highlighted the recent advancements in mechanized tunneling. This project is identified by an excavation diameter of 46.6 ft, with a covering ground layer of only 23 ft at the embankments and the centerline of the river. The TBM, manufactured by the German company Herrenknecht, was equipped with a pilot cutter wheel of 8.2-ft diameter in the center of the main cutter wheel. The main wheel had man-accessible spokes to allow the changing of cutter tools under atmospheric pressure conditions. The tunnel was inaugurated in October 2002.

The second project is the chain of four tunnels crossing the Thuringian Forest. The most important tunnel of this chain and at the same time the longest road tunnel in Germany is the 4.9-mile long Rennsteig Tunnel. The two parallel, two-lane tunnels are linked via 13 cross passages and equipped with 12 emergency refuge areas. Three shorter double-tube tunnels with lengths of 2,868 ft, 3,471 ft and 1.7 miles, belong also to that chain along the motorway A71. They all were commissioned in July 2003.

Public Opinion

Public opinion in Germany varies widely and is based on different aspects. Sometimes there is a strong opposition against a tunnel project because of environmental arguments, such as increased emission of dust or exhaust gases in the area of the portals or the ventilation shafts. Sometimes noise emission is the main concern. And sometimes concern arises because of increased traffic volume after the completion of a tunnel. In other cases, there is a tendency to discredit tunnels as a result of severe fires in some European tunnels during recent years or because of tunnel collapses during the construction phase.

To promote the further use of tunnels and the underground space, the national tunneling associations as well ITA-AITES have to explain to the public the undoubtedly advantages of those facilities. Tunnels and other underground structures contribute significantly to a well functioning, reliable and fast infrastructure as a vital precondition for a prosperous economy. They also are needed to provide the inhabitants, especially in the larger cities and industrial conglomerations, with human living conditions. Last but not least, tunneling plays a most important role as a crucial contribution to guarantee the mobility of persons and goods, which represents a high political priority.

Safety

Resulting from the catastrophic fire accidents in the Mont Blanc (1999), Tauern (1999) and Gotthard (2001) road tunnels, in the Daegu (South Korea) subway system (2003) or from the fire accident in the Eurotunnel (1996) which ended luckily, one of the major issues facing tunneling is safety. In connection with this, various working groups on a national and international basis were active during the past few years to analyze the safety standard in our tunnels and to adapt or improve the standards and technical guidelines for designing and operating road, railway and mass transit tunnels.

This also influences the design criteria for future tunnels. An important item in this direction is the question of upgrading already existing tunnels. This is a difficult
question also discussed in the public. The federal government of Germany has recently decided to spend about 230 million euros to improve the safety conditions in operated road tunnels and an extra 150 million euros for existing railway tunnels.

In many of the recent European research projects focusing on safety and security in traffic tunnels, Germany is decisively involved. Those projects are FIT (fire in tunnels), UPTUN (cost-effective, sustainable and innovative upgrading methods for fire safety in existing tunnels), L-SURF (design study for a large-scale underground research facility on safety and security) and EuroTAP (European Tunnel Assessment Programme).

Especially worth mentioning is the establishment of the ITA Committee on Operational Safety of Underground Facilities (COSUF) where, again, Germany plays an important role. This committee was installed in May 2005 and involves all the seven research and network projects issued by the European Union within the fifth European research frame program in consequence of the devastating fire accidents in various European road tunnels during the last few years.

In addition, the L-SURF project launched within the sixth European research frame program joined with COSUF. Although starting from these European projects described above, COSUF is open for all institutions, companies, consultancies, governmental organizations, etc., worldwide that are active and interested in the field of safety and security regarding underground facilities. COSUF is preparing its inaugural meeting combined with a technical seminar May 30-31, in Lausanne, Switzerland, the headquarters of ITA. The seminar will mainly focus on the results of the two projects Safe-T and UPTUN and give some information also about the findings of the other projects.

Funding
One of the obstacles impeding tunnel construction is funding. A lack of funding can cause delays in executing or even finalizing some specific projects. A lack of public money has led in several cases to a political decision to postpone a project. It is hoped and expected that after the successful installation of the road toll system for heavy goods vehicles (HGVs) using the motorways in Germany the situation will get better.

As is the case in some other parts of the world, tunneling projects are sometimes criticized for the high cost of construction. Some argue that tunneling is a waste of money. To answer those opponents it is necessary to explain to the public the tremendous advantages given with the use of tunnels, especially concerning public health considering the sewer networks and the regaining of vitality and human conditions especially in the center of the larger cities.

Another aspect is the acceleration of the railway passenger traffic to avoid or at least reduce domestic air traffic significantly, which is only feasible by using tunnels. The new high-speed railway lines in Germany have been well accepted since their completion about 15 years ago, and there is no principle public objection against the construction of additional high-speed lines as long as a cost-benefit balance is given. For the education of the general public, the politicians and the decision-makers, it is necessary to use modern tools of information. This includes daily and weekly magazines, technical journals, TV and radio programs and, last but not least, the Internet.

Contracts
Contractual practices have also been a topic of intense discussion in Germany. During the last 10 to 15 years, it could be observed that the climate between the owner and the contractor deteriorated to a certain degree, especially in relation to one or the other major project. This was caused not only due to the type of contract, but also because of an increasing lack of public money. This situation is linked with the risk of a reducing both the structural quality and the safety during the execution phase.

Such a development has to be stopped and teamwork among all parties must be regained. There is no doubt that both sides — the owners and the contractors — have to work in that direction. A very important item in the equation is the right form of the contract. In other words, a tricky contract from one side will create disputes and aggravate the general spirit on the site. First, experience could be won with two recent tunnel projects using public-private partnerships. In both cases rivers were underpassed: Warnow crossing in Rostock and Trave crossing in Lübeck. Some more projects are planned for using private money to pre-finance sections of new motorways including bridges and tunnels for the near future.

Future
The construction of transportation tunnels has been the top priority for some time, and this is expected to continue. Part of this is still linked with the reunification of the eastern and western federal states in 1990.

In addition to the previously mentioned 295 miles of tunnels anticipated over the next 10 to 15 years, additional works in eastern Germany are not far enough in the planning stage to be listed. Some 12.4 miles of old railway tunnels need to be rehabilitated or replaced. In addition, the rehabilitation of Germany’s sewers is another big task, as most of the existing system is far more than 100 years old.

Alfred Haack is managing director of STUVA, a non-profit research group based in Cologne, Germany, focused on urban, regional and long-distance rail and road transportation and other underground construction. He is also former president of the International Tunnelling Association (ITA).
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Messe Berlin
St. Albert was first settled northwest of Edmonton, Alberta, Canada, on the Sturgeon River. Founded in 1861 by Father Albert Lacombe, who built a chapel in the river valley, the settlement flourished after a group of French nuns moved to the city from Lac Ste. Anne. But those humble beginnings are a far cry from the growing and diverse population that today makes up the City of St. Albert.

Now home to approximately 56,000 people, the city’s demands for infrastructure have grown enormously. Most recently, this need culminated in the design and construction of Phase 1 of St. Albert’s Sanitary Trunk Sewer project, which constituted a major undertaking toward establishing ultimate conveyance for sanitary flows from existing and future neighborhoods — thus relieving existing sanitary infrastructure throughout the City.

Completed in April, Phase 1 involved the installation of 6,000 ft of 48-in. sanitary trunk sewer through an existing, mature neighborhood adjacent to many local historical sites. Depths in excess of 82 ft made microtunneling the preferred, if not the only viable, method of construction. However, several challenges still faced the design and implementation of the project, including concept development, working area constraints, constructability, funding and supply issues.

Project Background

In 1998, the City of St. Albert identified the need to manage flows through its existing multi-barrel inverted siphon that crosses the Sturgeon River. With ongoing development within the City and potential future annexation areas located north and northwest of the City’s existing boundaries, demand on the City’s sewer infrastructure was steadily increasing. Upgrades to the existing conveyance system were desperately needed.

Edmonton, Alberta-based Stantec Consulting Ltd. was retained by the City to review the original concept and identified the need for a new sanitary trunk sewer conveyance system. A three-stage approach to the construction of this new trunk sewer was selected, with Phase 1 construction providing the immediate benefit of in-line storage. Phases 2 and 3 will be constructed as required by future development to provide ultimate conveyance of wastewater from areas of St. Albert located north of the Sturgeon River, which bisects the City.

“Early in the preliminary design of Phase 1, we determined that the original open-trenching approach might not be feasible, in terms of cost and reasonable surface disruption through an existing residential area,” said Dan Willems municipal engineer for the City. “Trenchless construction using tunneling methods was immediately identified as an attractive alternative to the original concept.”

The final Phase 1 design included many unique design features to provide interim inline storage capacity, control releases to downstream infrastructure and provide for ultimate conveyance upon completion of the following two phases. In fall 2004, the project was awarded to Michels Directional Crossings Ltd., Nisku, Alberta, a subsidiary of Brownsville, Wis.-base Michels Corp., which was the low bidder at a total cost of $10.1 million CAD ($8.8 million USD). Michels’ proposed construction method was to use an Akkerman SL52.5 MTBM with Akkerman MT866 jacks.

“A detailed geotechnical investigation was carried out during the design period,” Willems explained. “To mitigate the long-term effects of corrosion in a high-volume, low-flow trunk sewer such as this, the design provided for the use of corrosion-resistant materials for use as the conveyance pipe.” Acceptable materials included PVC- or HDPE-lined reinforced concrete pipe, fiber-reinforced polymer pipe, or polymer concrete pipe. Michels Corp. ultimately chose the polymer concrete option.

Construction

From the beginning of the project, time was a top priority. Funding that was provided by the Infrastructure Canada-Alberta Program (ICAP) was contingent on crews completing work by the end of the first quarter of 2006. The construction deadline was set for Dec. 31, 2005, to ensure that there would be limited risk of losing the grant funding.

With the tight schedule, the Michels crew began site work in March 2005, with construction of the first jacking shaft at...
the downstream end of the trunk. After an auger bore was completed for a new 18-in. diameter sewer main — which completed the downstream tie-in of the Phase 1 trunk sewer to the existing system — microtunneling operations commenced in May.

“Soil conditions for seven of the eight tunnels consisted of a firm to hard clay, sand silt,” explained Pete Rasmussen, project manager for Michels Corp. “We were skirting the water table essentially the entire way.”

By June, crews started running into problems on the 890-ft drive through the sandy silt. Pipe supply soon dropped dramatically behind schedule and crews were forced to slow down tunneling to about one pipe a day — simply in order to maintain the momentum of the tunnel bore and prevent loss of the machine.

Jacking pressures soon started to climb due to the slow production, according to Willems. The crew installed bell piles behind the jacking plate in an attempt to recommence tunnel advancement before jacking pressures exceed the capacity of the jacks. But after about three weeks, it was jammed tight.

“We had to build a recovery shaft to remove the tunneling machine and re-setup all the equipment to finish mining,” Rasmussen said. “The delay ended up adding several weeks to the schedule of the project.”

The machine became stuck almost directly beneath the road centerline and the road was limited to one-way traffic for the duration of recovery and surface restoration activities. Once crews completed the second drive, Michels, Stantec, and the City negotiated a 24-hour work arrangement, which allowed Michels to bring in a second microtunneling crew to bring the project back on schedule.

The remainder of the project went relatively smoothly, but in addition to the supply delays, northern Alberta’s cold winter season also played a role, so the project deadline was extended to January 2006. The seventh drive was completed in late January, but the City later approved an extension that added an extra 1,000 ft northwest. The final drive was completed in April.

“As designed, the project consisted of 6,000 ft of 48-in. polymer concrete, with seven tunnels originally planned,” said Rasmussen. “But toward the end of the project, the City added an eighth tunnel, since they liked what we had done and they wanted us to keep going. We were already on site, so we just negotiated the extra tunnel.”

Nick Zubko is associate editor of Tunnel Business Magazine.

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While concrete is a quite strong material in terms of compression (pushing), it’s actually relatively weak when it comes to tension (pulling). So to compensate for this imbalance in concrete’s behavior, a material called “rebar” is commonly formed into it to carry the tensile loads.

Over the years, rebar (the shorthand for REinforcing BAR) has become an integral component of concrete segments used in tunnel construction. Typically formed from mild steel and given ridges for frictional adhesion to concrete, rebar is one of the most popular options for reinforcement.

However, the use of steel fiber reinforcement has recently become an increasingly viable alternative. Made from hard-drawn steel wire, steel fibers ensure a high-tensile strength and close tolerances. The wire is deformed with hooked ends and cut to lengths for reinforcement of concrete, mortar and other composite materials.

The performance of fiber depends on both the dosage (measured in kilograms per cubic meter) and the fiber parameters, including tensile strengths, length, diameter and anchorage. A key factor for quality fiber is the relationship between the length and the diameter of the fiber — the higher the lift-to-drag (l/d) ratio, the better the performance.

Steel fibers can provide increased ductile concrete with a high load-bearing capacity — resulting in thinner slabs with equal or better performance than their mesh counterparts. In addition, they allow efficient crack control and durability, as steel fiber slabs reinforce the structure throughout the entire matrix of the concrete, unlike mesh, which is localized to one or two layers. Steel fibers can be added at the concrete plant or at the jobsite directly into the back of the truck mixer, after which the pre-reinforced concrete is poured.

During the construction of two recent tunnels, the contractors chose to use steel fiber reinforcement in favor of conventional rebar reinforcement. What follows are short case studies for each of these examples.
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The Big Walnut Outfall Sewer is an extensive upgrade program for Columbus, Ohio. Part 2 of the project includes three miles of 12-ft diameter tunnel, five shafts, one mile of 42-in. sewer and an interconnect structure. The project was designed by URS Corp., supported by Lachel & Associates, and is being constructed by a joint venture of Ohio-based McNally Tunneling and Kiewit Underground.

The tunnel, located about 70 ft below the water table, is being driven through glacial tills and glacial outwash deposits comprised of sands, gravels, cobbles and boulders. Crews are using a Lovat earth pressure balanced (EPB) TBM to drive the tunnel and assemble the one-pass tunnel segments. Once installed, a Linabond corrosion protection liner will be applied to the inside face of the tunnel.

The segments were originally designed as conventional rebar reinforced. But at the direction of the contractor, Hatch Mott MacDonald was brought in to design the steel fiber reinforced segments as an alternative to the conventional design. The redesigned segments use a combination of steel fibers manufactured by the Bekaert Group, in addition to conventional rebar to resist the manufacturing, installation and in-situ forces.

Segment reinforcement consists of 50 lbs per cu yd of Bekaert’s Dramix RC-80/60-BN steel fibers and a small rebar cage. The rebar cage was determined to be required to resist forces imposed on the segments by the TBM during installation. Steel fibers were added to the concrete mix using an automated Incite dosing system capable of delivering up to 7 lbs per second of glued Dramix fibers. A total of 19,000 bolted and gasketed segments were required.

During operations on the Cigar Lake Uranium Mine, ore was extracted from artificially frozen ground (to control groundwater and ground conditions) using the jet boring mining method. These methods were conducted from dedicated freezing and production tunnels, developed in bedrock under and remote from the ore body. Due to variable ground conditions throughout the mine, several standard tunnel geometry and ground support schemes were used.

The excavation and support of underground works was undertaken using two basic development methods: drill and blast with conventional ground support and the TBM using a pre-cast concrete tunnel lining as permanent support. Conventional ground support included various types and thickness of shotcrete; steel fibers, wire mesh, screen and straps, cable bolts, steel sets, etc. More specialized support systems also included lattice girders, spiling, fiberglass rock bolts, cast-in-place concrete, and consolidation grouting.

Visual assessments by geology/engineering staff are done on a regular basis to document ground conditions. Use of the TBM for the development of freeze and production tunnels is relatively unique.

The liner, with a nominal thickness of 12 in., was made of pre-cast high strength concrete designed to meet ground conditions specific to the Cigar Lake mine. The TBM excavated a 16.7-ft diameter heading with a finished ID of 14 ft. The annular space between the liner and rock mass was filled with lightweight cellular grout filler and six concrete segments were required for each meter of tunnel advance.

Con-force, which was the manufacturer of the one-pass, pre-cast tunnel segments, poured approximately 39 cu yds per day into 20 to 30 forms, using 53 kg per cu meter of Bekaert’s RC80/60BN steel fiber. Concrete strength reached approximately 105 Mpa in seven days and about 120 Mpa in 28 days.

The forms are made of concrete for the curved surface, one face and two ends. The side forms were wood and the top face was three-fourths covered with a curved steel form that allows the insertion of a vibrator into the top of the segment to consolidate the concrete and smooth the faces.

Striped segments were stacked outside the plant with spacers between each row and a plastic cover to protect them from the elements. Casting was performed daily until March 2005. The project consumed approximately 265,000 lbs of RC80/60BN steel fibers.

Nick Zubko is associate editor of Tunnel Business Magazine.
Hatch Mott MacDonald is pleased to be providing civil, tunnel and systems engineering services for the Beacon Hill Station and Tunnel Central Link Light Rail Project.
A long buried problem in Austin, Texas, was finally solved when tunneling and boring was used to install new pipe with minimal disturbance to the surface. For more than 15 years, residents in the neighborhood had complained about wastewater discharges from the Little Walnut Creek interceptor. Infiltration and inflow were the problem with the 42-in. pipeline that runs beneath a stream and has manholes rising out of the water every 100 yds. When it rained, the sanitary sewer would overflow into the creek.

During the late 1980s, the City originally proposed replacing the interceptor, but residents blocked the project over concern that the proposed open-cut construction would disrupt nearby neighborhoods and cause environmental harm to the creek. Unhappy residents also blocked a redesigned project.

But all that changed when the Environmental Protection Agency’s Region 6 presented the Austin Water Utility with an administrative order requiring the central Texas utility to eliminate sanitary sewer overflows (SSOs) by December 2007 to protect its water supply. Austin is located in the Highland Lakes area of Texas and has a number of water features, including Barton Creek and the Barton Springs Edwards Aquifer, a sole-source drinking water aquifer and one of the most prolific artesian aquifers in the world.

Little Walnut Creek

One of the most challenging and critical tasks was the Little Walnut Creek Tunnel Interceptor Project. City officials wanted a product with a proven track record and a leak-free joint system. They conducted an extensive evaluation and chose not to include any other fiberglass pipe products besides HOBAS centrifugally cast, fiberglass reinforced, polymer mortar (CCFRPM), which has a track record of proven performance in the United States dating back to 1984.

Under the City of Austin’s Clean Water Program (CWP), this third and final design was assigned to national engineering and consulting firm Brown and Caldwell (BC), one of several engineering firms involved in the many mandated projects.

In a combination of engineering and community relations, BC’s design used a TBM to construct a new 10,000-ft, 96-in. diameter primary tunnel in one continuous run with no intermediate shafts. The $12.7 million project design called for a 60-in. fiberglass carrier pipe that was specified in order to increase the pipeline’s useful life compared with other materials.

HOBAS CCFRPM pipe exceeded the specifications and was selected, with 72 psf stiffness and flush bell-spigot couplings. To expedite the time to place each carrier pipe within the tunnel, two insertion shafts were utilized. The first pipe placed was at the midsection of the tunnel and was a special bell-by-bell CCFRPM pipe.

Subsequent pipes were carried into the tunnel from two insertion points, one at each end. Pipes were brought in with the bell trailing and blocked in place. Blocking was straightforward and rapid due to the flush exterior of the coupling. The simple push-together assembly of the couplings sped insertion.

Long life was of primary importance to the City of Austin. The fiberglass pipe’s inherent corrosion and abrasion resistance contribute to its time proven...
longevity. The City was especially impressed with the quality control at HOBA'S manufacturing facility in nearby Houston. Representatives completed an extensive and thorough audit of the system from raw material through finished product and testing. This resulted in an approval by the City of Austin's Standard Products List without any reservations.

Installation was assigned to KM&M JV of Solon, Ohio. Lee DuPont, project manager, said, “There are things that fiberglass pipe do can for a contractor in a tunnel that other pipes can’t. It is very easy to install compared to concrete pipe due to weight. Steel pipe is a pain in tunnels because of the working conditions, having to weld joints and so forth.”

The mining crews worked 140 ft below the surface in the Austin hill country during the hot Texas summer. The choice of fiberglass pipe increased their efficiency. Because of the pipe’s high strength, it has a much thinner wall than many competing products. This was of great benefit on the Little Walnut project, since it was a perfect fit to the available pipe carrier and provided extra room for alterations in pipe alignment within the primary tunnel, which was constructed of steel ring beam and wooden lagging. “Our initial bore was right at 99 in., that’s the machine we had available. The ribs were about 4 in., so the primary tunnel provided plenty of working space for the 60-in. liner. Our TBM was 31 ft long. With a trailing sled to accommodate the conveyor and spoil-removal cars, this totaled 90 to 100 ft. We were placing the primary support right behind the cutting head. We encountered all solid rock the whole way; the conditions were pretty consistent,” said DuPont.
Crews installed 60-in. HO BAS CFRPM pipe with 72-psi stiffness and flush bell-spigot couplings. To expedite the time to place each carrier pipe within the tunnel, two insertion shafts were utilized.

Some of the tunnel was located within right-of-way of existing streets. Crispin Ruiz, who handles public information for the Austin CWP, said, “The public appreciated the fact that it was a tunnel and didn’t disrupt the neighborhood. The residents were also concerned about any disruption to the sensitive environment around Little Walnut Creek. So, from the neighborhood’s perspective, it’s been a very successful project just because it didn’t disrupt their day-to-day lives.”

Shoal Creek
Another Austin CWP installation was part of the overall plan. The Shoal Creek Tunnel Project reached its first objective with the finishing of the Mainline Tunnel excavation. The tunnel lining is a 66-in. CFRPM pipe, with 72-psi stiffness and FWC couplings. It was used to replace the 54-in. reinforced concrete pipe (RCP) wastewater line that was exposed within the banks of Shoal Creek. The creek was vulnerable to flooding and the existing line had a potential breech, so the project was included in the Austin CWP and installed by W.L. Hailey of Nashville, Tenn.

The 3,200-ft run was completed after the crew negotiated two tight radius curves of 400 and 600 ft that made up about half of the drive. They also had to reconfigure the cutter head in place with 500 ft remaining in the drive because of a change in geology from 500-psi clay to 10,000-psi limestone.

The Crosstown Shaft was excavated at the same time the 66-in. fiberglass pipe was being installed. The main part of the job was completed when the mainline tunnel was connected to the Crosstown Shaft, which carried flow to the existing Crosstown Tunnel. Other elements of the project included junction boxes, directionally drilled lateral connections, several short open-cut runs and the rehabilitation of several existing lines and manholes.

Barton Creek
The City of Austin also took a unique approach to its Barton Creek Lift Station Relief Tunnel, which was awarded to Dibco Underground of Ontario, Canada. It began when the contractor set up the work area in Zilker Park, just north of Barton Springs Road.

The project was planned to avoid disrupting activities in the park and on nearby Toomey Road. It provides a 33-inch diameter fiberglass pipe installed in two sections of a tunnel. A shallow tunnel in Zilker Park is about 1,700 ft long, and the 33-inch pipe extends into the existing interceptor with the annular space filled with grout.

A drop shaft joins the shallow tunnel to a deeper tunnel that extends for 1,600 ft under Barton Creek to the shaft site off Toomey Road. The main shaft at Toomey is about 70 ft deep and has a temporary lift station built within the shaft to lift the wastewater to the adjacent South Austin Outfall.

The temporary lift station will be underground, and will operate until mid-2010, when it will be taken offline by a deeper tunnel system.

Stan Evans, Austin CWP project manager, said, “Fiberglass was chosen for these projects for a multitude of reasons. The most important one is that the Austin Water Utility established a policy long ago to have all new pipe that it installs, at least large diameter pipe, to be a fiberglass type pipe so that they wouldn’t have to deal with the constant problem of corrosion.”

That is something the Austin CWP is experiencing now, with concrete pipe and the maintenance effort that it generates. This is especially important when it comes to having to relining those pipes or — as the CWP is in the process of doing for some of them — having to replace them.

“And another factor is the tightness of the joint that the pipe provides,” Evans added. “That’s obviously a wonderful thing compared to the long-term outlook for the old joint installations with RCP that over decades are eventually going to allow leakage.

“That means two things: we’re either releasing wastewater to the environment or we’re taking in groundwater, which we do not want to have to do because that increases the flow in our lines, can cause overflows and create quite a bit of additional load to treat at our plant. During an unusually rainy event, it can actually overwhelm our plants.”

The pipes specified on this project were 72-psi pipe stiffness. The higher stiffness provides greater safety factors against external buckling due to long-term hydrostatic head and also during the grouting operation.

“The stiffness requirement was the decision of the designer, which determines what the contractor provides and installs,” Evans explained. “We are also concerned about the design life. The manufacturer tells us it could last 100 years, which is great because we have a hard time getting concrete pipe to last 50 years. Being able to put something in the ground that we can have some faith in, that is going to demand minimal maintenance and won’t just rot away, is really a blessing.”

These are just a few of a series of projects on which fiberglass pipe has been used. Austin has plans to use it on many more because of its strength, long life and ease of installation.

This article was submitted by HO BAS.
North American Microtunneling Project Update

By Nick Zubko

CALIFORNIA
Sacramento
Michels Corp., Brownsville, Wis., has two 1,100-ft drives remaining on the West Sacramento Force Main project for the Sacramento County Regional Sanitation District. Currently, crews are experiencing conditions at the drive shaft under the barge canal, which involves preparations to remove the machine and using divers to pour an entrance in the shaft.

Working as a subcontractor to Mountain Cascade Inc., Livermore, Calif., Michels is installing the entire 8,000 ft of 60-in. reinforced concrete cylinder pipe with Akkerman microtunneling equipment. Ground conditions have mostly consisted of silt, however, progress has continued better than anticipated and Michels now expects to complete the project by mid-June.

FLORIDA
Miami
Huxted Tunneling, Palmetto, Fla., was recently awarded a project for the City of North Miami Beach, which will involve the installation of 335 ft of 54-in. Permalok steel casing pipe for a 36-in. water main. The bores will cross four CSX railroad tracks and I-95 using Iseki microtunneling equipment in a single drive, 26 ft deep. Construction is expected to begin during the second quarter of 2006.

Orlando
Huxted Tunneling is continuing its work on the Eastern Regional Reclaimed Water Distribution System Phase II for the City of Orlando as a subcontractor to Garney Construction.

Huxted was delayed on the Econ River crossing, due to a differing site condition, after installing 600 ft of the 1,620 ft of 66-in. Permalok steel casing. The final drive, a 350-ft run to install 66-in. Permalok, was completed during the delay on the river crossing. The project is now scheduled to be completed by the second quarter 2006.

GEORGIA
Atlanta
Huxted Tunneling has started microtunneling operations on the City of Atlanta McDaniels Basin Combined Sewer Separation project contracted by the RPL/IMS joint venture. This project requires the installation of about 6,000 ft of 8- to 30-in. No-Dig pipe. Huxted will mobilize three different Iseki Unclemole MTBM’s and one Akkerman GBM to complete the project. Microtunneling began in February with the microtunneling work scheduled for completion at the end of 2006.

HAWAII
Honolulu
Frank Coluccio Construction Co., Seattle, completed the Hamakua Sewer Rehab project in early February. The $23 million project for the City and County of Honolulu involved installation of 6,300 ft of 30-in. ID Meyer pipe using an Iseki 1000 Unclemole through ground conditions consisting mostly of sands and corals.

Kailua
Frank Coluccio Construction started Phase II of the Kalaehe Reconstructed Sewer Project the first week of January. A continuation of the extensive sewer program being undertaken by the City and County of Honolulu, the project involves the installation of approximately 5,300 ft of 48-in. pipe.

Thus far, crews have used an Iseki 1200 to microtunnel approximately 1,600 ft of the entire project, working through ground conditions that include a mixture of sands and corals. Coluccio is looking to finish the project by the end of this year.

NEW JERSEY
Rahway
Northeast Remsco Construction, Lakewood, N.J., completed the final drive on the RVSA Gravity Relief Sewer in April. The $10.98 million project for the Rahway Valley Sewerage Authority consisted of nine drives to install 6,000 ft of 42-in. Amitech polycarbonate pipe using a Herrenknecht AVN 800. The project also involved construction of manholes and a cast-in-place diversion chamber.

Challenging elements of the project included one 660-ft microtunnel drive under Rahway River, in addition to two more drives that traveled under residential streets, one 560 ft and the other 820 ft. Microtunneling was performed through silts, clay, silty clay, shale and decomposed shale.

NEW YORK
Dewitt
As of December, Northeast Remsco Construction had started working on the $2.7 million Eastern Branch Pipeline for the Onondaga County Water District. The new pipeline is designed to serve as a water transmission main to replace the existing line inside a culvert that had become exposed.

The microtunneling portion of the project will be performed with a Herrenknecht AVN 1200 to install 700 ft of 60-in. Permalok steel pipe in one drive. Crews will tunnel through soft silt and clay 3 ft below the surface with 25 ft of water under multiple sets of railroad tracks. Northeast Remsco has already completed the steel sheeting jack-and-receive pits and expected to start microtunneling in November.

NORTH CAROLINA
Charlotte
The global tunneling division of Dyalco, Portland, Ore., completed six of the original seven microtunnel drives it was commissioned to construct as part of the Southwest Water Transmission Main Phase-A project for the Charlotte-Mecklenburg Utility District. The seventh microtunnel drive was changed to a hand-mined liner plate tunnel and it has also been completed.

Working with S.J. Louis Construction Inc. of Mansfield, Texas, Dyalco is performing a total of 12 drives using four different tunneling methods. The microtunnel portion involved installing
8-ft diameter steel casing with a Herrenknecht AVN 1800D slurry pressure balance MTBM.

The remainder of the project involves construction of two 8-ft diameter hard rock tunnels with a Robbins dual-shield TBM, which is under way, and two more drives to install 8 ft, 6 in. diameter liner plate with a Herrenknecht MH-2 shield excavator.

The final drive, an 8-ft, 6-in. diameter hand-mine through fractured rock with liner plate, has been completed and the final soft ground liner plate drive is under way. Shafts are being done with a mix of New Austrian Tunneling Method, driven caisson and sheet pile with internal bracing.

**OHIO**

**Cincinnati**

Michels Corp. is currently working on the last of five drives on the Mariemont SSO Elimination project. Since starting the project in July 2005, Michels has completed approximately 3,550 ft of the 4,000-ft project to install 36-in. Meyer polymer concrete pipe using Akkerman microtunneling equipment.

Crews have encountered ground conditions consisting of silty clay sands, plus several overhead electrical relocations. Michels Corp., which is working as a subcontractor to Sunesis Construction, was awarded the project by the City of Cincinnati Metropolitan Sewer District. The final 450-ft drive was expected to be completed in mid-April.

**Cleveland**

After starting work on the South Early Action project in November 2005, Michels Corp. is addressing an undetermined problem with 60 ft remaining on the fourth of five drives. Michels is using Iseki microtunneling equipment to install approximately 3,000 ft of 36-in. Hobas pipe for the Northeast Ohio Regional Sewer District.

Through the first three drives, ground conditions have consisted of silts, sands, clays and possibly cobble, but during the first drive, crews encountered a major obstruction that resulted in retrieving the machine through a rescue shaft.

Once crews drilled the shaft, they were able to retrieve the head on the machine, repair it and continue mining. At press time, a revised estimation for project completion could not be provided.

**RHODE ISLAND**

**Providence**

Modern Continental, Cambridge, Mass., completed the final drive on the CSO Control Facilities Program, OF 032 Facilities project in December 2005. Commissioned by the Narragansett Bay Commission, the $9 million project involves installation of 2,000 lf of 48-in. Hobas pipe and two large cast-in-place structures via microtunneling.

Ground conditions throughout the project consisted primarily of rock, but temporary slowdowns occurred throughout as a result of an outcropping of rock on the fourth drive, in addition to granite block wall on the final drive. Crews used a Soltau RVS-60, in addition to a Wirth 15-in. pilot-bore rig to complete the project.

**VIRGINIA**

**Alexandria**

Huxted Tunneling was scheduled to return to the I-95/Route 1 Interchange project by November 2005, for Phase II
of the project. However, microtunneling has been delayed due to a redesign of the remaining alignment that resulted from a conflict with an existing sewer line. Huxted is now to install 1,400 ft of 42-in. Can Clay pipe using an Iseki Unclemole. The Virginia DOT project is at the south end of the Woodrow Wilson Bridge Project being built by Corman Construction. Huxted completed the first phase of the project in March 2004.

**Alexandria**

Huxted Tunneling is currently installing 260 ft of 26-in. Permalok steel casing pipe for the Potomac Yard Development Waterline A project. The waterline crosses three CSX high-speed commuter rail tracks and two WMATA light rail tracks just south of Reagan National Airport. Huxted currently expects the project to reach completion in May.

**WASHINGTON**

**Renton**

Frank Coluccio Construction has completed the fifth of seven drives on the $7.7 million Fairwood Interceptor Project for King County. Having completed the first five drives to install 2,873 ft of 42-in. Permalok casing and 24-in. PVC carrier pipe, crews are currently performing supplementary open-cut work. Ground conditions consist of glacial till with cobbles and boulders. Coluccio expects the two remaining drives, which are each approximately 300 ft long, to be completed by mid-July. Once microtunneling is completed, crews will have additional asphalt paving and open-cut work left to complete the project.

**Shoreline**

Frank Coluccio Construction has been slated to begin working on the Hidden Lake Project for King County this fall. As part of a $20 million project, Coluccio will perform the microtunneling portion, which involves installation of approximately 1,500 ft of 42-in. Permalok with 24-in. PVC pipe in four drives.

Using the Iseki 900 from the Renton project, crews will work in ground conditions expected to consist of glacial till, sand and cobbles, while potential external factors include the project’s residential surrounding and relatively tight working quarters. Coluccio anticipates the project should be wrapped up in the first part of 2007.

**CANADA**

**ALBERTA**

St. Albert

Michels Corp. completed microtunneling for the City of St. Albert, a suburb of Edmonton, the first week of April. The project initially involved 6,000 ft of microtunneling to install 48-in. Meyer pipe, but was extended to 7,000 ft toward the end of the project.

As the prime contractor on the project, Michels used Akkerman microtunneling equipment to excavate through silty clays and occasional shales. On several instances, intermediate jack stations were needed to contend with the variance in ground conditions, which ranged from silt to shale, back into clay and back into silt again on a single drive. Michels also commissioned a second crew to perform the job in two shifts and continue its progress.

Nick Zubko is associate editor of TBM: Tunnel Business Magazine
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Robbins 20-in. Cutters

The Robbins Company announces its newest innovation — the 20-in. cutter for utilization on hard rock TBMs. The new cutter boasts industry-leading production life, with 35 to 40 percent more ring wear volume than the company’s 19-in. cutter. The increased life reduces the number of cutter changes necessary, which increases TBM availability.

The 20-in. cutter weighs only 3 percent more than the 19-in. cutter, which has been a great success in hard rock tunnel boring since The Robbins Company introduced it 15 years ago. Back-loading 19-in. cutterheads are now being utilized on several Robbins TBMs, including the Karahnjukar, Iceland, project (on three Robbins TBMs) and the Liaoning, China, project (on two Robbins TBMs).

The 20-in. cutter requires a hoist when loading and unloading the cutter into the cutterhead like the 17-and 19-in. cutters, which are utilized on most large hard rock TBM projects. They will be deployed first on the back-loading cutterhead of the 14.4-m diameter hard rock TBM for the Niagara Tunnel project. The 20-in. cutters can fit in existing Robbins front-loading cutterheads made for 19-in. cutters.

“We were pleased that Strabag, an experienced contractor, has elected to use a Robbins machine on the Niagara Tunnel project with the new 20-in. cutters,” noted Ian Cahoon, Robbins product manager for cutters. “We expect that they will be pleased with the performance of the equipment and the reduced number of cutter changes.”

Allentown MR-3300 Combination Rig

The MR-3300 from Allentown Industries is a new development in refractory replacement technology. It combines the proven high-performance of an RP-20 Refractory Pump and a 3,300-lb pan-type mixer in a configuration that is convenient, practical and functional — completely self-contained on a trailer-mounted rig. The versatile machine offers numerous features that, when combined, make mobilization, setup, production and cleanup a much simpler task.

The MR-3300 boasts an output of up to 30 tons per hour for distances of 300 to 500 ft horizontally, or 250 ft vertically. Powered by a 155-hp John Deere 6068ST water-cooled diesel engine, the unit features a hydraulic pressure washer, 42-gal self-storing water tank and a 30 cu ft hopper with blending paddles and front access panels for easy maintenance. Other features of the MR-3300 includes conveniently located operator controls, four-point lifting eyes and mixer grater safety lock.

Akkerman GBM-Powered Cutter Head Introduced

Akkerman’s new Guided Boring Machine (GBM)-powered cutterhead gives contractors installing pipes with a diameter larger than 18-in. ID a more productive choice in their installation when using the guided boring method. Previously, the upsizing of the pilot bore to the final diameter was accomplished by the two-pass method of installing smaller diameter augers and temporary casings that were supported by temporary casing spacers.

Saving valuable time and space, contractors performing the installation of these pipes can now use a powered cutterhead (PCH) to install the larger diameter pipes with ease. The PCH proceeds as a three-pass method, where the pilot tubes are first installed by using the Akkerman GBM frame and guidance system. The bore diameter is then increased to approximately 11 in. by installing temporary casings and augers. Finally, the PCH is installed behind the temporary casings and reversing the auger flow direction toward the reception shaft. After it is connected to the hydraulic supply of the power unit, the cutterhead is thrust into the soils and its rotating cutterbit excavates the soil to the final diameter needed for the product pipe. Spoils are transported through the temporary casings to the reception shaft and new pipe sections are added in the launch shaft as needed.

Advantages of the PCH include the amount of cutterhead torque available at the cut face. The two-pass method with the temporary casings and auger inside the product pipe required the augers to rotate the cutter bit as well, thereby reducing the amount of available torque at the cut face.

The powered cutter head uses separate supplies for the auger rotation and the cutter head rotation providing up to 48 hp to excavate the cut face, allowing significantly more control over the amount of soils excavated. Dual lubrication inlet hoses allow lube to be distributed to the outside diameter of the pipe string as well as the cut face.
**EVENTS CALENDAR**

**2006**

**APRIL**

22-27 ITA-AITES World Tunnel Congress 2006, Seoul, South Korea, ITA, Web: www.ita-aites.org

**MAY**

15-19 Grouting Fundamentals and Current Practice, Colorado School of Mines, Ph: (303) 273-3714, Fax: (303) 273-3719
Web: www.mines.edu/outreach/cont_ed
E-mail: skieffer@mines.edu

30-31 Boston Rehab Roadshow, Boston, Benjamin Media Inc. Ph: (330) 467-7588; Fax: (330) 468-2289
E-mail: info@benjaminmedia.com
Web: www.rehabroadshow.com

**JUNE**

10-15 North American Tunneling, Chicago, UCA of SME, Ph: (612) 825-8933; Web: www.auaonline.org

30-31 Vancouver Rehab Roadshow, Vancouver, Benjamin Media Inc. Ph: (330) 467-7588; Fax: (330) 468-2289
E-mail: info@benjaminmedia.com
Web: www.rehabroadshow.com

**SEPTEMBER**

10-13 APWA International Public Works Congress & Exposition, New Orleans, APWA, Ph: (816) 472-6100
E-mail: apwa@bbs.pubworks.org

17-20 TAC National Conference, Vancouver, Tunneling Association of Canada, Ph: (780) 401-8286; Web: www.tunnelcanada.ca

**OCTOBER**

30-31 Valley Forge, Pa., Rehab Roadshow, Valley Forge, Pa.
Benjamin Media Inc. Ph: (330) 467-7588; Fax: (330) 468-2289
E-mail: info@benjaminmedia.com
Web: www.rehabroadshow.com

4-6 31st Annual Conference on Deep Foundations, Washington, D.C., Deep Foundations Institute, Ph: (973) 423-4030
Fax: (973) 423-4031

21-25 WEFTEC 2006 Annual Conference & Expo, Dallas, WEF
Ph: (800) 666-0206

**2007**

**JANUARY**

22-26 World of Concrete 2007, Las Vegas, Ph: (414) 289-4141
Web: www.worldofconcrete.com

**MAY**

5-10 ITA-AITES World Tunnel Congress 2007, Prague, Czech Republic, ITA, Web: www.ita-aites.org

**JUNE**

10-13 RETC, Toronto, SME, Ph: (303) 973-9550, Fax: (303) 979-3461
E-mail: davis@smenet.org

**2008**

**SEPTEMBER**

22-27 ITA-AITES World Tunnel Congress 2008, New Delhi, India, ITA
Web: www.ita-aites.org

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