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TUNNELING & UNDERGROUND CONSTRUCTION

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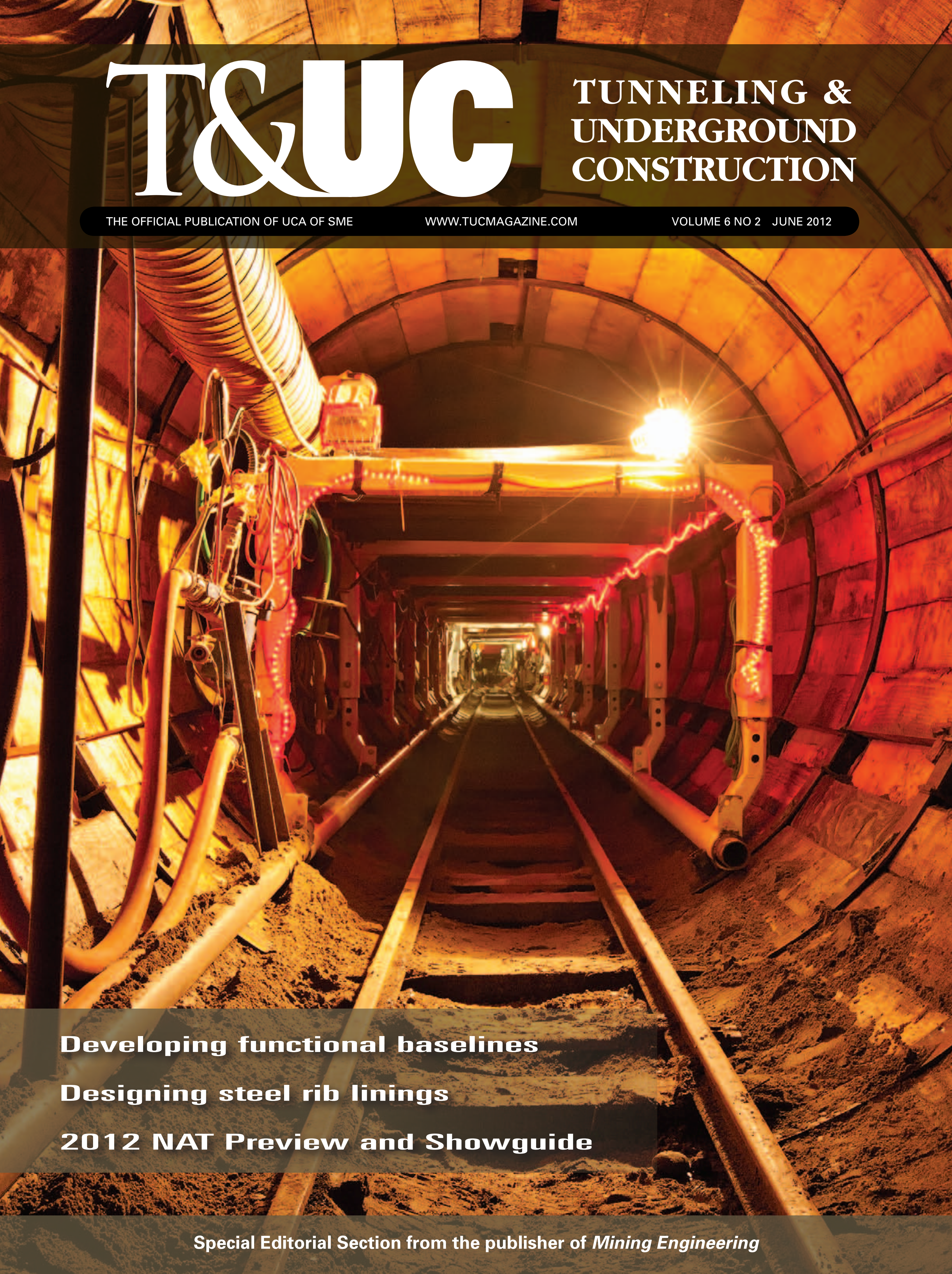

Developing functional baselines

Designing steel rib linings

2012 NAT Preview and Showguide

Special Editorial Section from the publisher of *Mining Engineering*

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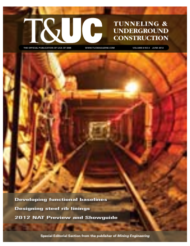
COVER STORY



COVER — It is difficult to establish geotechnical baselines on soft ground projects that require the use of closed-face TBMs. But there are alternatives, page 14. The NAT conference is set for June 24-27 in Indianapolis, IN, page 24. Cover photo shows Portland's Portsmouth Force Main project — Segment 2. Photo by Sue Budner and courtesy of Jacobs Associates.

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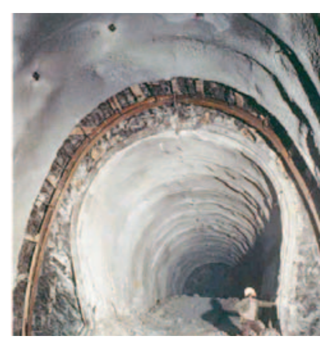


DEPARTMENTS

T&UC

CHAIRMAN'S COLUMN

Summer brings busy, and exciting times to the tunneling industry

Greetings everyone. Hard to believe how time flies; it seems like only yesterday I was commenting about the successful Fox conference in these pages and now summer is bearing down on us full speed.

I do look forward to summer in our industry — while tunneling work essentially goes on year-round, it seems like there is even more going on in the summer and we are able to get more done. Better weather, better access and all around better conditions to make solid progress on all the work that is underway.

The other key event this summer that I am looking forward to is the NAT Conference in Indianapolis, IN, June 24-27. Make sure to check out Steve Kral's preview article on page 24 for the highlights, and I am sure you will find this NAT to be one of the best ever.

More than 800 industry professionals are expected to attend the confrence this year and there will be 116 exhibitors on hand.

Personally, I look forward to presentations, the awards recognizing outstanding achievement and visiting the exhibit hall to see the latest in technology from all of the hard-working people in our industry.

This year there are more than 100 technical presentations in 20 sessions scheduled.

The NAT conference is also a great place to catch up with friends and colleges from current or past years' experience and see what current opportunities might exist. It is a great time meeting with great people.

Additionally, there will be short courses offered at NAT as well as a field trip to Martin Mariett's North Indianapolis underground mine and quarry at the conclussion of the technical part of the conference.

> **Personally, I look forward to presentations, the awards recognizing outstanding achievement, and visiting the exhibit hall to see the latest in technology from all of the hard-working people in our industry.**

It really is a great conference and I hope to see you there.

And speaking of good people, I would like to take a minute to recognize Paul Scagnelli of Shiavone Construction. Paul has served on the executive committee for the UCA of SME for many years. Unfortunately, his term limits are up, and Paul will be stepping down from the EC this summer. Paul probably spends most of his time involved with our industry on the East Coast, so many people who focus on the West Coast may not have had a chance to get to know him. But take my word for it, he has been very involved in many aspects of our industry and is always trying to make it better. Paul has been active in the UCA Executive Committee, and his efforts will be missed. We have always been able to count on Paul for some candid comments of his opinions and thoughts because he tells it like it is.

Please join me in thanking him for his past efforts, and I am sure that he will stay involved with the UCA in other ways over the coming years.

See you in Indianapolis.

Jeffrey Petersen,
UCA of SME Chairman

Reasons for the cancellation of ARC project come under fire

The Access to the Region's Core (ARC) tunnel project was to be the largest construction project in the United States. But it was abruptly halted in 2010, when New Jersey Gov. Chris Christie canceled the project, citing revised cost estimates that would have raised the cost of the project to $11 billion, and potentially $14 billion.

However, a report from the Government Accountability Office (GAO) published in April 2012 said, despite Christie's claims of changing estimates, the range of estimates had, in fact, remained unchanged in the two years before he announced that he was shutting down the project. And state transportation officials had said the cost would be no more than $10 billion, the report said.

Christie also misstated New Jersey's share of the costs, according to the report. He said the state would pay 70 percent of the project; the report found that New Jersey was paying 14.4 percent. And, while the governor said that an agreement with the federal government would require the state to pay all cost overruns, the report found that there was no final agreement, and that the federal government had made several offers to share those costs.

A report from the Government Accountability Office published in April 2012 said, despite Christie's claims of changing estimates, the range of estimates had, in fact, remained unchanged in the two years before he announced in 2010 that he was shutting down the project.

The state needed a leader "willing to say no" to the multibillion-dollar tunnel project, Christie said in a speech at a George W. Bush Institute conference at the New-York Historical Society in Manhattan.

But to others, the report by the GAO proved the Republican governor killed the tunnel in 2010 out of political expedience.

The tunnel had been sought to ease congestion in the two aging tunnels that bring Amtrak and NJ Transit trains into Manhattan — a choke point in the region's transportation network. Christie yanked billions in state funding for the project in October 2010 after con-

(Continued on page 11)

East Side Access project delayed

Excavation problems in Queens, NY might delay the completion of the East Side Access railroad project until 2019, according to Metropolitan Transportation Authority Chairman Joseph Lhota.

The TimesLedger newspaper reported that Lhota said the project was having issues on the Queens side while speaking in Melville, LI on May 9.

The East Side Access project will connect the Long Island Rail Road's (LIRR) Main and Port Washington lines in Queens to a new LIRR terminal beneath Grand Central Terminal in Manhattan. The new connection will increase the LIRR's capacity into Manhattan and shorten travel time for Long Island and eastern Queens commuters traveling to the east side of Manhattan.

The MTA released a statement saying the agency "is re-evaluating the risks in the construction schedule for the East Side Access and plans to present its findings to the MTA Capital Program Oversight Committee."

The statement continued: "One preliminary analysis of risk factors has indicated the completion date may move to 2019 as East Side Access construction intensifies in the busiest passenger railyard and the largest passenger rail interchange in the nation."

Lhota told the Long Island Association that tunneling under the Sunnyside railyard, where trains from Amtrak and its Acela trains are stored, has become a problem.

"Contaminated soil languishes and must be disposed of properly and, unlike closer to the water, the ground is soft rather than rocky," Lhota said.

Lhota said workers have also run into springs and brooks "that nobody knew existed below the surface."

At last estimate, the monumental project was supposed to cost $7.3 billion, but it was not yet known whether the new hurdles would increase the tab.

The East Side Access project had previously been expected to be completed in late 2016, then 2018.

"We were looking at 2018, but the most recent analyses put the opening at 2019," Lhota said. "I don't want to see it go past 2019."

The East Side Access Project has been excavating tunnels approximately 36 m (120 ft) beneath Manhattan streets. Two tunnel boring machines (TBMs) were used, one manufactured by SELI and one manufactured by Robbins. The two TBM's in Manhattan made eight successful tunnel drives starting and ending at various points along the alignment. At the end of November 2009, all of the upper tunnel drives were completed and in 2011, all the Manhattan tunnels were successfully mined.

Excavation to create the caverns with in Grand Central Terminal are currently under way and have an estimated completion date of early 2012.

The East Side Access Project is also excavating four new tunnels in Queens. Two slurry TBMs that can tunnel through soil have been purchased by the contractor. ■

Robbins TBM finishes run in Mexico City

Mexico's largest tunnel boring machine (TBM), a 10.2-m (33.5-ft) diameter Robbins earth pressure balance (EPB) machine, completed its successful tunneling run on March 1, 2012. The machine, for a consortium of ICA, Carso and Alstom, excavated 7.7 km (4.8 miles) of tunnel in highly variable ground including watery clays, cobbles and large boulders. The new Metro Line 12 will be the first in a decade for Mexico City, a rapidly growing metropolis of more than 20 million people.

The tunnel route took the Robbins TBM to within meters of a 16th century church, active sewer lines, building foundations and other structures. Real-time settlement monitoring was rigorous throughout the project, and the crew was diligent in maintaining earth pressure during excavation. TBM elements including a two-liquid back-filling system with rapidly hardening cement also aided in settlement reduction.

(Continued on page 13)

The Robbins EPB excavated below city streets, building foundations and a 16th century church, all while keeping settlement below 5 cm (2 in.).

OneTunnel.org reaches 100,000 documents

The participating organizations of OneTunnel.org are pleased to announce that, as of May 2, 2012, more than 100,000 documents have been uploaded to the site, representing more than 1.6 million pages of technical information vital to the mining, metals, minerals and underground construction industries. Douglas C. Peters, President of the trustees of OneTunnel.org, stated, "We are very pleased to have been able to reach this milestone in less than four years since inception of the OneTunnel.org archive. We will continue to add documents as quickly as possible to broaden the historical and topical content for our participating societies' members and the industry as a whole. We also hope to have additional societies join OneTunnel.org in the near future." OneTunnel.org is an international endeavor to build a comprehensive digital library that is targeted specifically to the needs of professionals working in those fields.

OneTunnel.org is a single repository of stored documents ranging from 1871 to the present day. It consists of several participating societies, each supplying its own technical material. Members of each participating society have unlimited access to the site and can download as many documents as they want at no cost. Nonmembers can download documents for a fee. Corporate and library subscriptions are also available.

The cost of most existing digital libraries is out of reach for most individuals or even small companies. So, participating societies can offer OneTunnel.org to their membership as a benefit for less than $1 a month per member. This is a win-win situation for all parties involved. Societies can offer an excellent membership benefit that, in most cases, members would not be able to afford themselves.

OneTunnel.org was established in 2008 as a 501c3 organization with two main objectives. The first is the consolidation of knowledge into a centralized repository and the dissemination of this information to the industry. The second is in the archiving and storage of older materials that are disintegrating due to age.

Participating organizations include:

- American Institute of Mining, Metallurgy, and Petroleum Engineers (AIME).
- Australasian Institute for Mining and Metallurgy (AusIMM).
- Deep Foundations Institute (DFI).
- International Marine Minerals Society (IMMS).
- Society for Mining, Metallurgy, and Exploration (SME).
- Southern African Institute of Mining and Metallurgy (SAIMM).
- U.S. National Institute for Occupational Safety and Health (NIOSH).

For more information about OneTunnel.org, contact Gregg Tiedeman, phone 303-948-4248, e-mail tiedeman@smenet.org. ■

Tunnel refurbishment moves ahead on Crossrails project

Site workers have begun drilling wells at Connaught Tunnel to draw down the water table ahead of work to deepen and widen the 130-year old tunnel in East London, Crossrail announced in May.

Once the wells are completed, drawing down of the water table will begin, which is required ahead of works to widen and deepen the central section of the Connaught Tunnel so it can accommodate Crossrail's larger trains. The water table is also being lowered to allow for the pump house shaft to be deepened by another 7 m to 25 m (23 ft to 82 ft) for it to accommodate modern pumping equipment that will work to keep the tunnel dry.

During the coming weeks, the 130-year old pump house will be removed brick by brick and will be donated to Newham Council. This attractive Victorian building is too small to accommodate the larger modern pumping equipment that will be installed as part of the tunnel's major refurbishment. Demolition of the former North London Line station at Silvertown is commencing.

Work in Connaught Tunnel are well under way with the ballast – loose stone ground cover – and rail tracks already removed. Major piling works are also under way at the western approach to the tunnel in order to strengthen the ground. Survey work to identify potential unexploded ordnance from the second World War has been completed in the tunnel's western approach, with the all clear given. Crossrail's archaeologists have opened their fourth and final trench for the site, searching for possible evidence of human activity dating back 6,000 years. ■

Survey work to identify potential unexploded ordnance from the second World War has been completed in the tunnel's western approach with the all clear given.

ARC: GAO reports different project costs

(Continued from page 3)

struction of the 14-km- (9-mile-) long tunnel from Secaucus to Midtown Manhattan had begun. It was set to have been completed by 2018.

Christie had said he was concerned the project's cost would rise to more than $14 billion, basing that on Federal Transportation Administration estimates. Federal officials had estimated its cost range from $9.8 billion to $13.7 billion.

The GAO — the investigative arm of Congress — found that NJ Transit officials, over which Christie has control, had actually projected a maximum final cost of $10 billion, $4 billion lower than what the governor had projected.

The 29-page report — which was ordered by New Jersey Sen. Frank Lautenberg, a Democrat — also found Christie overstated the state's share of the cost, saying it would be on the hook for most of it.

But the GAO found the state's direct share would have been $1.3 billion, or 14 percent of the project's total, as of an April 2010 analysis. The Port Authority of New York and New Jersey was expected to cover 35 percent of the funding for the tunnel. The federal government would pay the rest.

Michael Drewniak, a spokesman for Christie, said the GAO report confirmed the governor's belief that the project was too expensive. He also said it didn't include certain costs — such as a $775-million bridge that would have to be replaced.

Drewniak also argued the Port Authority funds should be counted as financial support from the state, since spending them would detract from the amount the agency would spend on other New Jersey capital projects.

Some of the money set aside for the tunnel project was used for highway funding.

A spokesman for U.S. Transportation Secretary Ray LaHood said the GAO report "sets the record straight."

"It's disappointing that the project was canceled before these facts got the attention they deserved," said spokesman Justin Nisly.

The report found that federal and state officials had not signed a final agreement on cost overruns before the project was canceled. The GAO's findings were first reported by *The New York Times*.

Amtrak and NJ Transit spokesmen declined to comment on the report. A Port Authority spokeswoman didn't respond to a request for comment.

Few expect the GAO report to revive the ARC plan.

Lautenberg and others have thrown their support behind a new effort, Amtrak's Gateway Project. It would add tunnels, with two new rail tracks, across the Hudson River. Unlike ARC, though, it lacks federal and state funding, except for a $15-million federal appropriation to study the concept.

Metropolitan Transportation Authority chairman Joseph Lhota has endorsed Gateway as the best bet to improve access to Manhattan from New Jersey and to relieve overcrowding at Penn Station, the busiest passenger rail station in the country.

Gateway's total cost could reach $13 billion to $15 billion, an official said. ■

NY water tunnel to make room for megaships

The construction of a new $250-million, 3.2-km- (2-mile) water tunnel will be a boon both to Staten Island and to the Port of New York and New Jersey as it clears the way for new megaships to enter the port.

The tunnel will upgrade the island's water infrastructure as well as move forward the dredging of a deeper harbor channel needed to keep the region's port business globally competitive.

The officials said all the work on the siphon tunnel would be finished by 2014.

Work will include dredging a channel that would be deepened to approximately 15 m (50 ft), from the current depth of 13 m (45 ft). The Port Authority and the Army Corps of Engineers will be responsible for the dredging.

The city and the Port Authority are splitting the cost of the tunnel project, with the city's Economic Development Corporation managing the project, *The New York Times* reported. The dredging necessitated the replacement of two existing tunnels, one that dates to 1917, the other to 1925. They are 17 and 18 m (56 and 60 ft) below the surface, respectively, and would be too close to the channel bottom after the dredging, officials said. The new tunnel will be 31 m (100 ft) below the surface.

The dredging is needed to accommodate larger cargo ships that are expected when the expansion of the Panama Canal is complete in the next couple of years.

The cost of the $250 million project will be born equally by the city and the Port Authority. ■

Bids sought for S.F. subway stations

The next phase of San Francisco's $1.6 billion Central Subway project is set to begin.

The San Francisco Municipal Transportation Agency is taking bids for a $210 million project to build the Union Square station, a depot that will be a key connecting point for passengers.

Construction companies have until July 11 to submit a bid, with a decision on the winner coming soon after. Work is expected to begin in 2013 and be completed by 2017.

The station, which has already been designed, will feature entry points from Market Street and Union Square.

The SFMTA's board of directors approved a $233-million pact last year for tunneling work.

A majority of funding for those projects is expected to come from a $942-million federal grant. While the SFMTA has expressed confidence that it will receive the grant, an announcement of that funding will not be made until later this year.

The Central Subway will extend Metro service 2.7 km (1.7 miles), connecting South of Market with Chinatown. ■

ROBBINS: Largest TBM in Mexico bores 25.4 km

(Continued from page 6)

"Settlement stayed within the limits of between 2 and 5 cm (0.8 to 2 in.) throughout the bore," said Ismail Benamar, ICA Tunnel Manager from the TBM launch through 2011.

The complexities of the densely urban project location have been a hallmark of the project from the start, when the machine underwent onsite first time assembly (OFTA) from a shaft on a city street. "OFTA has the benefit of no pre-assembly — everything was delivered directly to the site and assembled here. The assembly went very smoothly, and it was a little over three months before we started to turn the cutterhead and push the machine forward," said Ron Jelinek, Robbins field service technician.

The machine was launched from the small shaft in February 2010 and proceeded to break through into seven cut and cover station sites ranging from 150 to 190 m (490 to 620 ft) in length. During each hole-through, the machine underwent routine maintenance and was re-launched. Despite the numerous intermediate stations and the time required to walk through each station, advance rates topped out at 135 m (443 ft) per week, and averaged 400 m (1,300 ft) per month.

Custom EPB features aided in the efficient excavation, and included a two-stage screw conveyor with an initial ribbon-type screw to allow the passage of boulders up to 800 mm (2.5 ft) in diameter. Active articulation allowed the machine to negotiate tight curves down to 250 m (820 ft) in radius with no segment deformation.

Upon completion, the 25.4 km (15.8 mile) Line 12 of the Mexico City Metro is the longest in the system. The Mexican Federal District predicts that the new line will carry an average of 367,000 passengers daily, making it the fourth busiest commuter rail route in the capital. ■

The 10.2-m- (33.5-ft-) diameter Robbins EPB was designed with a two-stage screw conveyor to excavate mixed ground including large boulders.

FEATURE ARTICLE

Developing functional baselines

Establishing geotechnical baselines on soft ground projects that require the use of closed-face tunnel boring machines (TBMs) is difficult. It is hard to see the face when mining and the excavated material is combined and mixed, all of which makes baseline quantifications challenging. In an attempt to meet underlying objectives of minimizing bidder contingencies, allocating or sharing risks and paying for conditions only if they occur, nongeotechnical baselines (i.e., functional baselines) have been developed. These have been used on the District of Columbia Water and Sewer Authority's Clean Rivers (DCCR) Blue Plains Tunnel (BPT) project. This article examines the development of such functional baselines and how they were implemented on the BPT project.

The challenge with baselines and soft ground tunneling

In general, baselines are established to convey to bidders the results of a geotechnical investigation for a given project, allocate subsurface-related risks between the contracting parties and to facilitate the evaluation of differing site conditions. Baselines can be both qualitative and quantitative. An example of a qualitative baseline is the description of the behavior of the ground when unsupported and below the ground water table (e.g., flowing conditions). An example of a quantitative baseline is one that can be measured and verified during construction (e.g., hardness of rock).

To the maximum extent possible, baseline statements are best described using quantitative terms that can be measured and verified during construction (Essex, 2007).

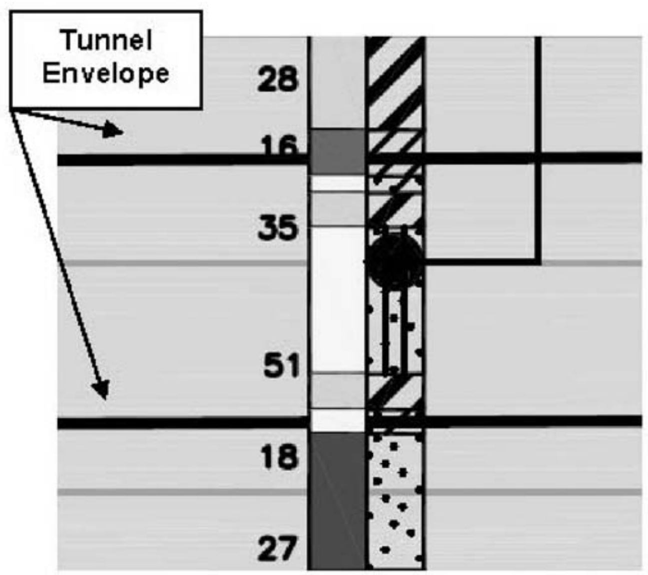
In tunneling, the ability to measure and verify quantitative baselines, specifically in soft ground tunnels excavated using earth pressure balance (EPB) machines or slurry pressure balance (SPB) machines, is challenging: the face is not visible during mining; and the excavated material is combined through the tunneling process, frequently with conditioners, foams and/or slurry. Therefore, baselines for conditions other than specific geotechnical properties or ground should be considered. This article provides principles for selection of functional baselines and describes how a functional baseline can be implemented on a project.

William W. Edgerton, Amanda M. Morgan and Ronald E. Bizzarri

William W. Edgerton, member UCA of SME, is Principal with Jacobs Associates; **Amanda M. Morgan**, member UCA of SME, is project engineer with Jacobs Associates and **Ronald E. Bizzarri** issenior technical manager with District of Columbia Water and Sewer Authority, e-mail morgan@jacobssf.com .

FIG. 1

Example of soil groups.



The soil group challenge

When considering baselines for tunneling or other projects, the first two basic issues typically addressed are identifying the items to be baselined, and determining how the baselines will be quantified. One important item typically baselined is soil stratigraphy, often referred to in terms of geologic units. However, developing a baseline for a geologic unit may not be appropriate for all geologic settings because there could be many different soil types within a given geologic unit, and each soil type can exhibit different behavior and engineering properties.

An alternative means of organizing subsurface information in a manner that addresses soil behavior relevant to tunneling and other forms of excavation has been implemented on several projects in the United States. These projects have grouped together soils of similar behavior and engineering properties and referred to the groups as "soil units" or "soil groups." The groups are then typically assigned baselines for soil properties such as strength, grain size, permeability, mineralogy and abrasivity. Additionally, the amount and distribution of those groups anticipated to be encountered within the tunnel envelope are also considered a baseline. For example, Fig. 1 shows a soil profile from a tunnel project in the Washington D.C. area, which used soil groups to describe the anticipated ground conditions. The boring log sticks show the unified soil classification system (USCS) designation on the right and the soil group designation on the left (different soil groups are shown by the break lines). Each soil group was assigned baselines for various soil properties, such as grain size. The amount and distribution of each group anticipated to be encountered within the tunnel envelope was described using tunnel reaches. The estimated soil group percentage by volume to be encountered within the tunnel envelope was provided for each tunnel reach.

The challenge is how to accurately measure and verify the soil property baselines for each soil group once excavation has occurred. Take, for example, soil that is similar to the consistency shown in Figs. 2 and 3. A soil group for clay and a soil group for sand are now combined through the tunneling process and most likely mixed with foams, polymers or bentonite. How can you tell how much volume was clay and how much volume was sand? How can this baseline be verified and measured? Instead of trying to verify and measure baselines for geotechnical conditions, which are virtually impossible to measure in soft ground tunneling, another option is to baseline the contractor's construction activities that are required to handle the ground conditions. This is the concept behind the functional baseline.

Developing the functional baseline

In an attempt to meet the underlying objectives of minimizing bidder contingencies and pay for something only if it occurs, consideration should be given to developing baselines that can be measured by things other than geotechnical conditions (i.e., "functional" baselines). Functional baselines might include operational results obtained by the contractor — such as the amount of annulus grout pumped between the segments and the ground, the number and duration of cutterhead interventions, cutter wear or reduced tunneling advance rate. These functional baselines, if established, do not necessarily need to be included in the geotechnical baseline report (GBR), but can be included elsewhere, such as in the contract as a unit price or allowance type pay item. Development of functional baselines should consider the following principles:

- There should be some relationship between constructability (or construction or construction methods) and the ground conditions. Functional baselines to define conditions that are clearly mechanical in nature that the contractor does have some control over (either in the initial purchase of robust and/or new equipment or during maintenance) should be avoided.
- Functional baselines that could encourage behavior that increases risk, either in bidding or in operations should be avoided — e.g., baselines that minimize normal maintenance for which the contractor is responsible so that the owner pays for "repairs." Additionally, consider using incentives to encourage behavior that reduces risk. A cost-reimbursable approach to achieve the incentive is a possible consideration.
- Payment systems that favor one bidder over another because of differences in proposed means and methods should be avoided.
- The functional baseline and the approach should be relatively simple to understand and implement. Consideration should be given as to how the construction management team will have to verify and measure the functional baseline during construction, similar to how the classical geotechnical baseline would be verified and measured.
- Certain geotechnical baselines that are useful and can be more easily measured during construction should remain in the contract. Examples, depending on the ground and proposed methods of verification and measuring, include abrasivity, stickiness and permeability.

FIG. 2

Example of excavated material from an SPB machine.

It may be difficult to totally separate the factors the owner should be responsible for (e.g., the ground) from the factors for which the contractor should be responsible (e.g., machine, maintenance, etc.). In these cases, there may be ways to share the overall risk with the bidders and minimize the contingency that the bidders are forced to include in the bid price. An example of a tunneling risk that can be shared between the owner and contractor, while minimizing contingencies, is tunnel boring machine (TBM) cutterhead interventions.

TBM cutterhead interventions

One of the largest costs associated with soft-ground tunneling is differing site conditions related to cutter-

FIG. 3

Example of excavated material from an EPB machine.

head interventions. Some interventions are necessary to handle ground-induced problems (cutter wear, boulder removal), and some are necessary to handle mechanical breakdowns (hydraulics, pressure switches). A possible solution to equitably share the cost of these cutterhead interventions is to develop a functional baseline that is structured as a risk-sharing approach. A functional baseline for TBM cutterhead interventions was used on the DCCR project for the Blue Plains Tunnel (BPT). The BPT is a design-build project. Three teams were shortlisted and went through a collaboration period prior to submission of a technical and price proposal. At the time this paper was written, the Traylor, Skanska, Jay Dee joint venture (TSJD JV) had been awarded the project. Tunneling had not commenced.

Therefore, only specifics about how the contract documents were prepared are provided here.

The general approach for the TBM cutterhead intervention functional baseline is as follows:

- A specified amount of intervention time hours are carried by all bidders in the lump sum price.
- The construction management team (CM) records the number of intervention hours incurred during construction.
- If the hours are exceeded, then the contractor will be reimbursed as a cost-plus reimbursable item.
- If the intervention occurs on the critical path, the contractor will be reimbursed by both direct and indirect costs.
- If the intervention does not occur on the critical path, then the contractor will be reimbursed for the direct costs.

Details for how the functional baseline was developed and implemented on the DCCR BPT project are provided in the following sections.

Intervention time definition

Intervention time was defined in the contract documents as the time it takes to complete an intervention. Specifically, the intervention time begins when the first team enters the cutterhead to inspect the ground and check for safe working conditions, and it ends when the last team exits the cutterhead. Intervention time did not include the preparation time prior to accessing the chamber and the time required to become fully operational after the invention was complete. The time prior to and following an intervention was defined as tunnel excavation work stoppages and was included as a separate unit price pay item.

During the collaboration period, the bidders were asked to provide the owner with an estimated quantity for intervention time based on the bidders' evaluation of the geotechnical conditions and previous project history. Based on these estimates, the owner specified the number of intervention time hours, which were carried in the lump sum, and the number of tunnel excavation work stoppages, which were included as a unit price item. Bidder input to the estimate quantity allowed for a reasonable time estimate for the baseline.

The construction management team is responsible for tracking the hours spent performing cutterhead interventions in accordance with its contractual definition. If the intervention time hours are exceeded, then the contractor will be paid using other bid items, discussed in the following sections. If the hours are not exceeded, then the hours simply go unused without credit to the owner. In addition, the amount of contract time established for the project is included the intervention time hours.

Exceeding the intervention time in the lump sum

Additional payment items were established in the contract to reimburse the contractor for any intervention time hours that exceeded those specified to be carried in the lump sum price. The payment method depends on whether or not the intervention is on the critical path of the project. If an intervention is required and tunneling is not on the critical path, then the contractor will be paid for the direct costs — including labor, equipment and materials and subcontractors associated with tunneling only. However, the contractor will not be allowed to charge markups. Payment for the direct costs was included in the project contingency allowance. This is an example of a shared risk approach because the contractor will be paid for the work performed for the intervention — beneficial for the contractor. However, the contractor will not be making a profit, which could encourage bad behavior — beneficial for the owner.

If an intervention is required and tunneling is on the critical path, which generally is the case, then the contractor will also be paid indirect costs including field overhead labor; equipment, plant and support services; home office general and administrative costs and profit in addition to its direct costs. Payment for the indirect costs will be included in a separate unit price item — the critical path delay. The contractor will also receive an extension to the contract time based on the amount of intervention time in excess of the time included in the lump sum.

The TBM cutterhead intervention functional baseline approach used on the DCCR BPT project achieves most of the functional baseline principles previously discussed. Examples of how the project approach met the principle goals are discussed below:

- Interventions for any reason are compensable under this functional baseline approach. Ground conditions — such as a boulder or wear of the cutters due to abrasive soils — can cause the intervention. General maintenance of the TBM — such as checking the cutter wear and general inspection — can also result in an intervention.
- The baseline encourages behavior that reduces risk to the owner. For example, the contractor will be reimbursed for performing interventions for inspecting wear on the machine and changing cutting tools, which reduces the chances for machine breakdowns and impacts to the schedule. Additionally, the contractor's risk of losing money during interventions for maintenance is greatly reduced since the contractor is reimbursed for this work.
- Since the contractor receives only direct costs for interventions not on the critical path, there is an incentive for the contractor to complete the work as quickly and efficiently as possible because there is not a profit during this time.
- All bidders are required to carry the same amount of intervention time in their proposals; therefore, no one bidder has an advantage over another.
- The approach is relatively simple to understand and implement, and much consideration should be given as to how the construction management team will have to verify and measure the baseline during construction, similar to the classical geotechnical baseline. For example, for the BPT project consideration was given to distinguishing "inspection" intervention hours from "repair" intervention hours. Consideration was also given to distinguishing repair hours associated with the ground from those associated with mechanical items not related to the ground. The need for simplicity in contract administration outweighed these considerations. As such, these differentiations were not implemented for this project.
- Certain geotechnical baselines — such as abrasivity, stickiness and permeability — can be more easily measured during construction. For the BPT project, these were left in the contract. However, such properties are not perfectly measureable during soft ground tunneling because of additives and the combined nature of the layers of material. Other means of field measurement may have to be implemented depending on the nature of the project.

The TBM cutterhead intervention functional baseline is a risk-sharing approach to more equitably share the risk associated with the cost of cutterhead interventions, which is one of the largest costs associated with soft-ground tunneling and, thus, one of the largest risks. Not only are interventions large-cost items, they pose many safety concerns and issues on soft ground projects. Because the contractor is being reimbursed for interventions with not only money but time, if on the critical path, disagreements about the effect of the ground on the machine and the risk associated with the ground are mitigated. Below is the contractual language for the TBM cutterhead intervention functional baseline that was implemented on the DCCR BPT project. The language was provided in the Division 1 specifications and the payment items were listed on the bid sheet. The language instructed how intervention time was to be carried in the lump sum and the payment method if the intervention time is exceeded and the tunneling is not on the critical path:

3. Lump sum (all other work payment item No. 2)

   e. 1,200 hours of intervention time shall be included in payment item No. 2. For payment of work in excess of 1,200 hours, refer to payment item Nos. 6 and 11.

   1. Intervention time is the time it takes to complete an intervention. Specifically, the intervention time begins when the first team enters the cutterhead to inspect the ground and check for safe working conditions and it ends when the last team exits the cutterhead. The intervention time does not start immediately when the cut-

terhead is stopped.

2. The amount of time established in Section 00520 for performance of work under this contract includes the 1,200 hours intervention time and all time associated with the estimated quantity of tunnel excavation work stoppages.
3. All tunnel excavation work stoppages, even those occurring during the 1,200 hours of intervention time, shall be paid for under payment item 5. [Division 1, general requirements, 01200 - 4]
4. Project contingency allowance (payment item No. 11)

   a. Payments under this payment item will be reimbursed in accordance with the provisions of Section 00520 and 00700.

   b. Tunnel plant and equipment associated with TBM mobilization will not be reimbursed under this payment item per Section 01505.

   c. This payment item covers the following work:

      1. Cost for work required to be done and identified during construction that is more than the amount of work quantified in established baselines:

         a) Intervention time to be paid per hour, in excess of the number of hours included in lump sum payment Item No. 2. These direct costs include labor, equipment and materials and subcontractors. Section 00700 markups will not be reimbursed under this payment item. [Division 1, general requirements, 01200 - 10.]

Other functional baselines for soft ground

Boulder baselines are typically described using either a number of boulders to be encountered or a description of nested boulders in the face of the machine. Establishing an accurate boulder baseline can be a challenge in itself, as the measurement of boulders in soft ground tunneling is difficult, if not impossible. The boulders encountered are hard to count, and their size is hard to measure since they are typically crushed or grinded on and then pushed out of the way. For a nested boulder baseline, it is hard to determine whether boulders are in a quarter, half or all of the face, since the only way to access the face is through an intervention. However, it is possible to determine whether the TBM is mining through bouldery ground by observing the torque on the machine, sounds in the chamber, the reduced tunneling rates and boulder remnants on the belt. One of the greatest risks when encountering boulders, other than having to perform an intervention to get them out of the face (which can be handled using a TBM cutterhead intervention functional baseline), is the reduced tunneling rate. Therefore, development of a reduced tunneling advance rate functional baseline can be established instead of establishing a quantity baseline for boulders in the GBR. Implementation of this functional baseline could be performed as follows:

- Establish a length of tunnel where boulders would be encountered — i.e., an impacted zone.
- Establish a reduced production rate that all bidders assume in their bid, which would be the baseline. For example, from Station 10+00 to Station 20+00, the advance rate of the TBM would be reduced by 20 percent. This time would also be included in the contract time for the project.
- The advance rate in the impacted zone would be compared to the unimpacted zone (i.e., the measured mile approach), and, if the advance rate exceeds the baseline, then payment would be handled by a unit price or allowance item. The measured mile should be based on sufficient length of tunnel before and potentially after the impacted zone. Furthermore, records documenting production, scheduled downtime and unscheduled downtime should be properly kept, such that the true advance rate can be determined.
- In addition to payment, the time above the baseline would be added to the contract time.

The benefit to this approach is that, while boulders are not easily measured in soft ground tunneling, advance rates are easily and commonly measured. The ground is what is causing the reduced advance rate. However, the verification is through measuring something other than the ground. All bidders include the baseline in their bids, and the payment for the difference does not result in bad behavior. The contractor will not include a large contingency in the bid because it will be paid for any reduced advance rate above the baseline and any time above the baseline will be added to the contract time.

Conclusion

While it is difficult to have a perfect baseline, functional baseline principles and guidelines for soft ground tunneling provide a means to measure and verify a baseline more accurately than do some classical geotechnical baseline approaches. Developing baselines that provide a better risk-sharing approach between the owner and the contractor can reduce the likelihood of differing site conditions. (References are available from the authors.) ■

FEATURE ARTICLE

New approach in the design of first lining steel ribs

In recent years, considerable advances have taken place worldwide in the design and construction of first tunnel linings. With these advances, there is a tendency to move away from traditional support that includes heavy open profiles of rolled steel arches, to a lighter solution with the use of an optimized tubular steel cross section rib, and shotcrete reinforced with steel mesh and/or steel fibers, providing a continuous support (Lunardi, 1982). The development of tubular ribs has provided greater design options, increasing flexibility to engineers and contractors while providing a efficient and cost effective construction method.

In this article, the authors describe numerical and experimental investigation on this problem, suggesting as a new first lining steel arch design approach by using tubular ribs cross section as new technical solution for first lining underground support.

Ground-lining interaction control is one of the most critical processes during the implementation of a tunneling project. Some of the design and construction decisions during a tunnel project are critical to reduce the ground movements around the excavated tunnel.

These movements have a direct effect on the tunnel stability and the design load of the lining system (Lunardi et al., 1994).

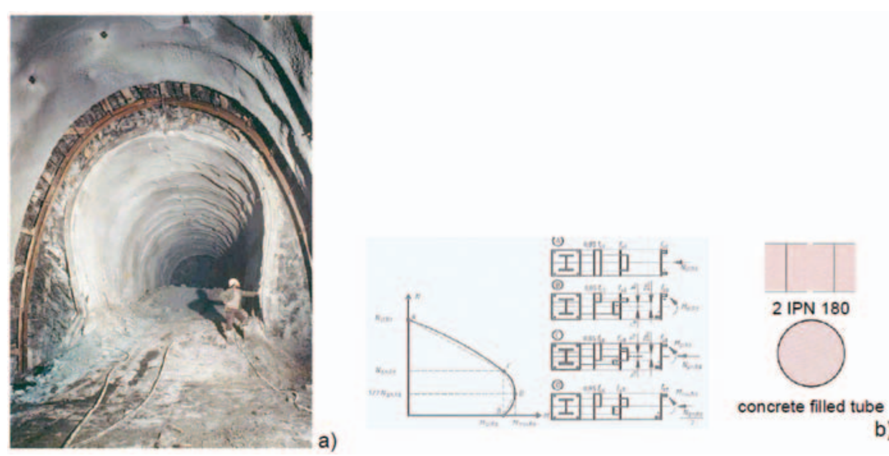
Tunnel linings are structural systems installed during and/or after excavation to provide ground support, maintain the tunnel opening, limit the ground water inflow, support appurtenances and to provide a base for the final finished exposed surface of the tunnel. Tunnel linings can be used for initial stabilization of the excavation, permanent ground support or as a combination of both (Hoek. et al., 1981).

Tunnel linings are structural systems, but differ from other structural systems in their interaction with the surrounding ground, which is an integral aspect of their behavior, stability and overall load carrying capacity. The loss, or lack of support provided by the surrounding ground, can lead to a failure of the lining. The ability of the lining to deform under load is a function of the lining's relative stiffness and the surrounding ground (Beiniawski, 1984). Frequently, a tunnel lining is more flexible than the surrounding ground. This flexibility allows the lining to deform as the surrounding ground deforms during and after tunnel excavation. This deformation allows the surrounding ground to develop strength and stability. The tunnel lining deformation allows the moments in the tunnel lining to redistribute the main load inside the lining that are axial or eccentric load. The most efficient tunnel lining is one that has high flexibility and ductility.

Open steel profiles (IPE, HE, IPN), typically used as first lining support, show performance weakness in their static structural properties in directions different than the normal and central position. In reference to particular local conditions, a closed circular profile will bring better performance conditions compared to an open

FIG. 1

a) Example of open profile buckling; b) calculation of the N-M domains for the two steel section types considered collborating with the concrete filling (Eurocode 4, 2004).



Carla L. Zenti, Giuseppe Lunardi, Bruno Rossi and Antonio Gallovich

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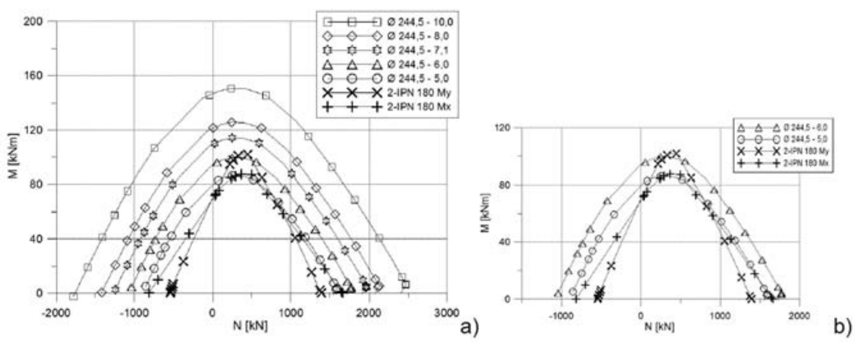
FIG. 2

Resistance domain comparison: a) all profiles analyzed; b) profiles selected for experimental activity (convention: positive compression strength).



profile. As an example of particular local condition, there is a nonhomogeneous contact between the profile and the soil, which may occur during the tunnel excavation progress and is not always found in a plane strain state. It is also acceptable to assume the worst performance conditions for a double "T" profile in the presence of a horizontal load component (Fig. 1a). These problems can be solved using a symmetrical axial cross, like a tubular rib. Substituting the open profile with the circular profile, with the same area, results in better stress redistribution, which ensures to the resistant cross section the ability to take control of axial and eccentric loads, acting along any direction (Bringiotti, 2003).

Numerical analysis

Some numerical analyses were made prior to the experimental activity. Those focused on finding the correct profiles to compare.

The numerical evaluations started by considering cross section area, moments of inertia and resistance modulus. This first assessment was made to define which profiles to compare. The different sections were evaluated considering the behavior of composite section in terms of diagrams N-M (axial force and bending moment, Fig. 1b). The calculation is in compliance with the requirements of Eurocode 4 and NTC 2008 (Italian Standard Reference).

Some assumptions were introduced in the calculation:

- It is not considered progressive damage of the section. This hypothesis turns out to be an improvement in the expected behavior of the standard rib. This assumption neglects the change of position of the neutral axis, caused by progressive damage of the concrete filling, considering this is one of the main causes of instability of open profile ribs.
- Tube ductility capability due to its geometry is not given. The circular profile gradually uses its own ductility capability, allowing its full exploitation. This is basically the worst condition for the tubular rib, which deliberately neglects its geometrical advantage.

These choices were made to be sure to determine, in a preliminary phase, the circular profiles that certainly would have matched the performance of open profiles.

One of the most important causes of rib instability is the presence of eccentric loads, which cause horizontal load components. This fact generates high bending moments that the geometry of the standard ribs, made by open profiles, is not able to take control of. The consequence is the necessity to use the largest profiles.

Referring to the diagrams proposed in Fig. 2a), which represent all the resistance domains analyzed, it is possible to see a resistance domain of the steel-concrete section wider for a circular section characterized by a diameter of 224.5 mm (8.8 in.) with a thickness changing from 6 to 10 mm (0.23 to 4 in.). This provides an increased resistance in compression and bending stresses. The numerical analysis also shows the different behavior of standard rib along the *x* and *y* axes.

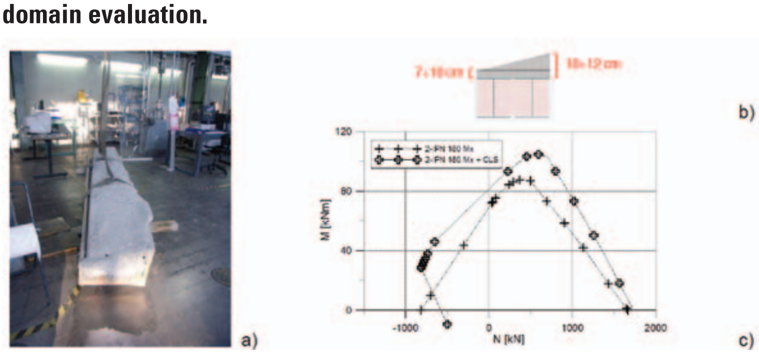
As a consequence of the assumption adopted during numerical analysis, it was decided to compare the standard rib with two different tubular ribs, the ones that reach the maximum bending moment of the standard rib along *x* and *y* directions (Fig. 3b). This decision was made because the real behavior of standard rib is something in between the ones along *x* and *y* axis.

The laboratory experimental activity compared three different types of ribs:

- TSH-T5: Tubolar rib — hollow profile circular section Φ 244.5 thickness = 5 mm - S275.
- TSH-T6: Tubolar rib - hollow profile circular section Φ 244.5 thickness = 6 mm — S275.

FIG. 3

Standard rib sample: a) photo; b) geometrical scheme; c) resistance domain evaluation.



- 2 IPN 180: Standard rib — 2 profile IPN 180 connected by 25-cm IPN 160 – S275.

It was chosen as the standard rib one of the most common profiles used in Italy.

Experimental activity

The experimental work was carried out in two phases. The first, conducted in the laboratory, was necessary for the validation of numerical analysis. The second, conducted on site, compare the structural response of the two types of ribs, the standard one and the tubular one.

Laboratory test. Laboratory tests were carried out at Politecnico of Milan. For each type of rib, four samples were prepared — two to be tested at 24 hours and two to be tested 48 hours after filling.

The samples were prepared in a job site in Milan. The filling concrete was not prepared in a laboratory, because it was intended to use one typically used on a job site and fill the sample with a sprayed concrete machine. The filling operation of the tubular hollow section was simple. The filling operation of the standard rib was more complex, as was the necessity to have a complete filled sample brought to obtain a trapezoidal sample instead of the desired rectangular section, as shown in Figs. 3a and b. The samples have not been adjusted to avoid damage, but it was necessary to study the trapezoidal sample resistance domain by a new numerical analysis (Fig. 3c). The calculations highlight a more than 15 percent strength increase in terms of maximum bending moment, which changes its value from 87.7 kN-m to 104.9 kN-m.

Figure 4 shows the static scheme used during the tests, it is referred to as a four-point flexure test. This test condition represents the ideal load condition for standard ribs. It was chosen to demonstrate that, in the ideal conditions for the standard rib, the tubular rib is able to match the same performance. If this happens, there are *n* load conditions in which the tubular rib has a better performance than the standard one. For example, it is enough to introduce a small eccentricity in the load to cause the instability of a traditional rib, while in the case

FIG. 4

Test set up: a) static scheme; b) tubular rib; c) standard rib.

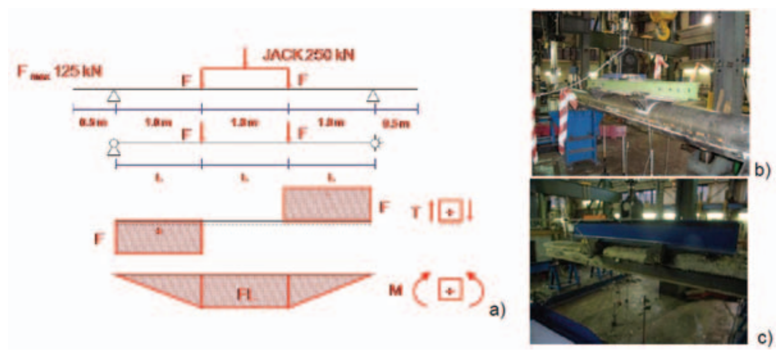


FIG. 5

Test results: 01,02 are referred to 24-hour tests, 03, 04 are referred to 48-hour tests: a) TSH-T5; b)TSH-T6; c) 2 IPN 180 + CLS ; d) average results.

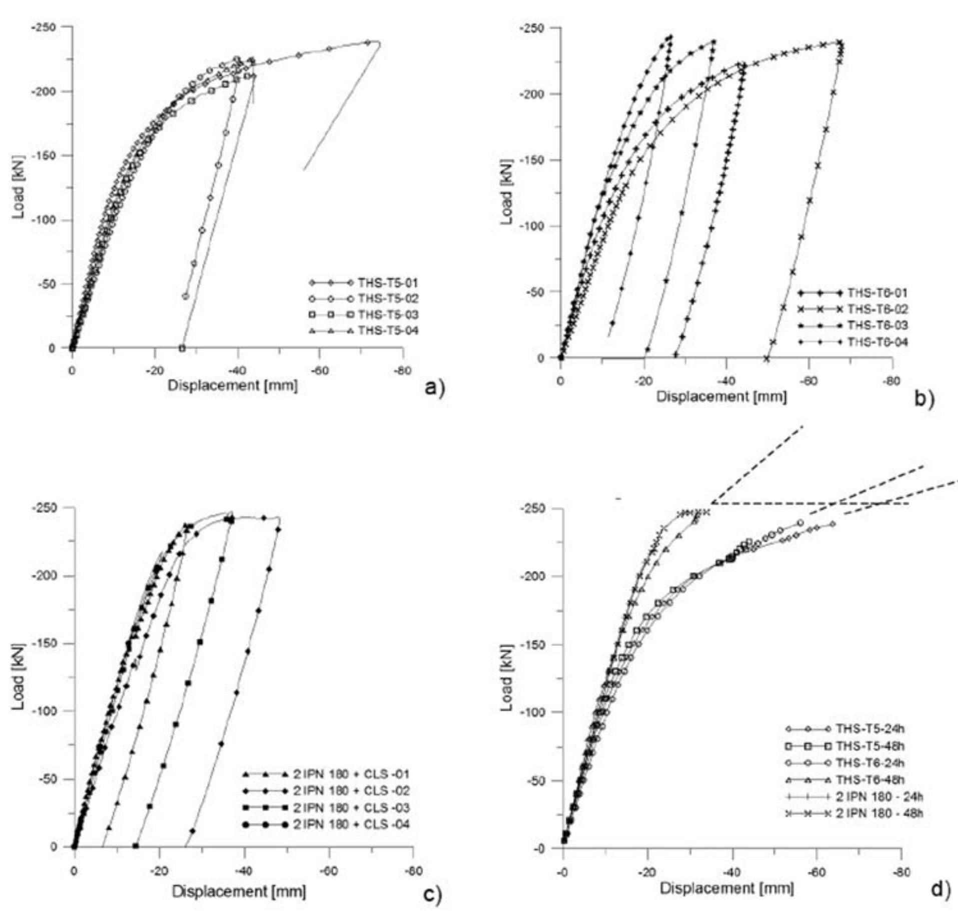
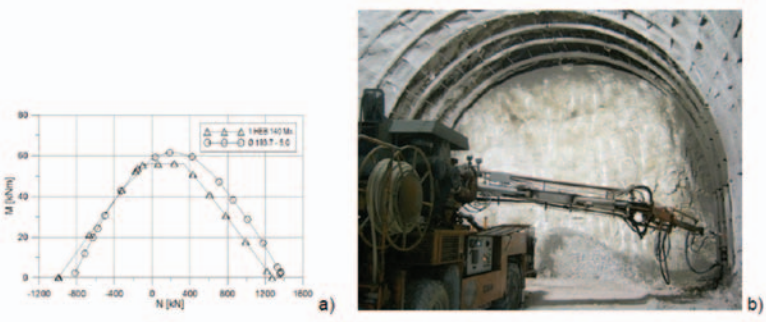


FIG. 6

Full scale test: a) resistance domain Comparison (convention: positive compression strength); b) tubular rib installation.



of the tubular rib, this does not cause any effect since it is an symmetrical axial profile.

Figure 5 summarizes the test results. Looking at the results, it shows the standard rib characterized by an elastic plastic behavior, while the tubular ribs show an elastic hardening behavior. In recent years, for example in seismic design, has been established the trend acknowledged by many standards, to allow structures to overcome the elastic phase, allowing large structural deformations in the plastic phase. It is possible to follow this design trend using tubular ribs but not using standard ribs.

At the end of laboratory investigation, it was possible to make some considerations. It is worth recalling that, in the case of the standard rib, a negligible shotcrete covering layer was not detected. This contribution is quantifiable in at least a 15-percent rise of the maximum bending movement that the section is able to undertake. This provision did not come from experimental results. The experimental analysis showed that, in ideal conditions using the standard rib, the tubular rib has comparable performance.

By replacing the open profile with the tubular hollow section, with the same steel cross section area, the last one has improved structural static properties, ensuring the ability to take control of axial and eccentric loads along any direction.

Full-scale testing of steel arch tunnel supports

The field tests described in this article have been performed to verify the compatibility of the tubular rib with the underground work operational needs and to confirm the results of laboratory tests conducted on static efficiency of tubular ribs. By monitoring, it was possible to compare tubular rib stress strain response against the ribs formed by open profile defined as standard ribs. The field tests were carried out in the Varano Tunnel, in a stretch at the north entrance from Foligno, within a rock mass belonging to the Maiolica Formation of good mechanical characteristics (Barton et al., 1974). Within this type of mass, a category A behavior, "stable core-face" (diagnosis phase, Lunardi, 2008) was expected.

The excavation tunnel section designed for this stretch corresponded to section type Ac. This section is characterized by a shotcrete reinforced standard rib made of a single HEB 140 installed every 1.5 m (5 ft) (1 HEB 140). The selected tubular rib for the full-scale test was the tubular hollow section characterized by a 193.7-mm- (7.6-in.-) diameter and 5-mm- (0.2-in.-) thickness in S275 Steel Class (TSH-193.7-T5). The tubular rib resistance domain is comparable to the one of standard rib (1 HEB 140), Fig. 6.a).

The field test performed verified good compatibility of the tubular rib with the underground operational needs. The tubular rib is stable and easy to handle during transport and installation. The buckling risk during installation, as a consequence of its high rigidity, has been eliminated. This ensures to work with a higher safety level.

The filling phase is fast and functional to ensure complete filling of the profile. The remaining operational phases necessary for tunnel construction remain unchanged.

In order to test the tubular ribs and compare them in terms of stress-strain response (monitoring phase, Lunardi, 2008), with the HEB 140 ribs, three sections were tested:

- Section 1: Length approximately 28.5 m (93.5 ft). Section type AC - tubular ribs, 193.7-mm- (7.6-in.-) diameter and 5-mm- (0.2-in.-) thick, installed every 1.5 m (5 ft).
- Section 2: Length approximately 28.5 m (93.5 ft). Section type AC - standard rib made of a single HEB 140 each 1.5 m (5 ft).
- Section 3: Length approximately 28.5 m (93.5 ft). Section type AC - tubular ribs 193.7-mm- (7.6-in.) diameter and 5-mm- (0.2-in.-) thick, installed every 1.8 m (6 ft).

This last section was tested after the evidence of good stress-strain response highlighted by monitoring in sections 1 and 2.

To verify the work in progress, within approximately 86 m (282 ft) of tunnel length, the following monitoring activities were conducted:

- No. 8 structural geological surveys of the face (a survey every 10 to 15 m or 33 to 40 ft) in order to determine the geological and geomechanical condition.
- Installation of No. 8 topographic measurement stations to evaluate the deformation response of the first lining (one station every 10 to 15 m or 33 to 40 ft).
- Construction of No. 3 stations for the rib stress

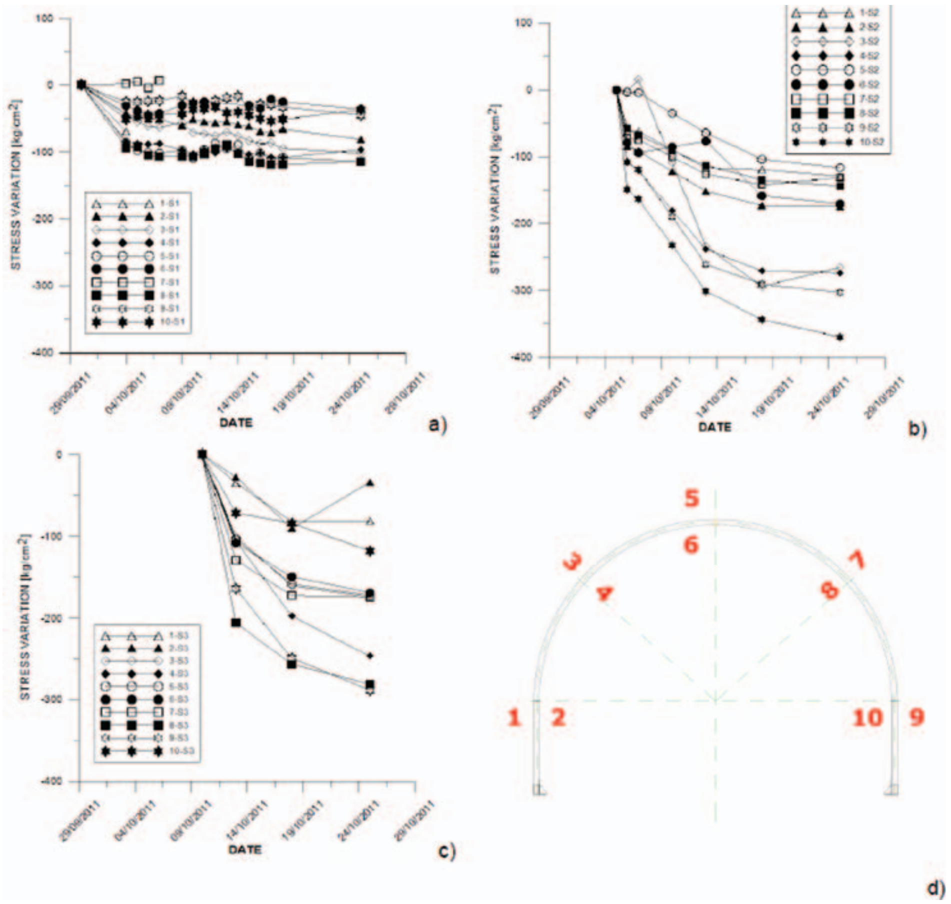
control (one for each section of the field test). Each station is characterized by two load cells placed at the foot of the rib and No. 5 pairs of strain gauges placed at entrances and exits of the rib corresponding to side wall, heading and top heading (Fig. 7d).

The mass presents homogeneous characteristics that have been demonstrated by geological surveys carried out at the face. The deformation response recorded in each test section was always within the elastic range, with displacement and convergence values below 0.5 cm, in rapid stabilization.

Evaluating the results of stress control stations, it is clear that stresses that affect tubular ribs are lower than the ones corresponding to standard ribs. This is particularly evident comparing the measured tensile stress on the tubular ribs in Section 1 (pk 22 +983.75) with the same stress at the standard ribs inside Section 2 (23 pk +013.76), Fig. 7a and b. In Section 3 (1.8 m or 6 ft installation step) the stress level present in the tubular rib remains below the corresponding stress level measured in the standard ribs with a 1.5-m (5-ft) installation step, despite the significant step increase.

FIG. 7

Results of stress control stations: a) Section 1; b) Section 2; c) Section 3; d) instrumentation positioning.



Conclusions

The numerical and experimental investigation confirms that the tubular hollow cross section shows better performance conditions compared with an open steel profile standard rib. Laboratory tests results confirmed the composite section performance of the tubular rib as usually modeled in the design phase. This assumption was not confirmed for the standard open profile rib. Field tests were carried out to evaluate the compatibility of the new type of ribs with underground work concerning the installation and stress-strain response. From an operational point of view, the tubular rib is stable and easy to handle during transport and installation. This ensures a high safety level to the workers. The high rigidity of the proposed profile eliminates the risk of possible buckling during the installation. In all sections tested, the deformation response recorded always maintained within the elastic range. The tensions measured at stress control stations in the tubular ribs showed significant lower values, compared with the corresponded standard open profile ribs.

The tubular hollow cross-section offers a better stress redistribution. This ensures the ability to take control of axial and eccentric loads along any direction.

Referring to a particular local load condition a hollow profile circular section has better performance conditions. A good example of this problem is the homogeneous contact conditions between the profile and the soil that may occur during the excavation of a tunnel. It is not always found on a plane strain condition.

It is acceptable to assume a double "T" worst working conditions in the presence of eccentric loads. These problems can be solved by using a symmetrical axial cross, like a tubular rib.

The tubular hollow section has improved structural statics properties, ensuring the ability to take control of axial and eccentric loads along any direction. (References available from the authors.) ■

FEATURE ARTICLE

North American Tunneling Conference heads to Indianapolis

The 2012 North American Tunneling (NAT) conference is expected to attract more than 800 tunneling and underground construction professionals. But don't let the North American part of the meeting's title fool you. Many of the attendees will come from all over the world.

The meeting is scheduled for June 24-27 at the JW Marriott Indianapolis Hotel in Indianapolis, IN. In addition to two and a half days of technical programming, the accompanying exhibit has attracted 116 exhibitors in 140 booths. And the conference will include short courses, a field trip and plenty of social activities that will give attendees the opportunity to catch up with each other.

A hosted reception and lunch in the exhibits area will allow attendees plenty of chances to catch up with each other and to take a look at the latest in tunneling technology.

Short courses

Two one-day short courses will be offered on Sunday. CEUs will be awarded for each. "Grouting in underground construction" will be conducted by Raymond Henn and Paul Schmall. This course will present an overview of the materials, equipment and grouting methods used in underground construction. Some of the subjects that will be covered include cements and admixtures, grouting equipment and practices, chemical and cementitious permeation grouting, jet grouting, compaction grouting, backfill and contact grouting, pre-excavation grouting and cellular grouting.

Several case studies will also be presented. And nine grouting experts will give lectures on various grouting methods and techniques.

"Sequential excavation methods in tunneling" will be led by Levent Ozdemir. The course will cover site investigation and data analysis for sequential excavation, numerical/analytical modeling and tunnel design, ground support analysis, construction monitoring and construction techniques used in sequential excavation.

Also included in the short course will be several case studies about sequential excavation tunneling. A panel discussion will also be held concerning the design and construction issues associated with sequential excavation.

Steve Kral,
Editor

Luncheon speaker and technical presentations

Monday's welcoming luncheon speaker will feature Thomas W. Traylor, chairman and chief executive officer of Traylor Bros. Inc. His company, founded by his father, is a national general/heavy construction firm that specializes in marine and tunneling work.

NAT 2012 will also feature more than 100 technical presentations in 20 sessions. Topics include case histories, planning, design and technology. A proceedings volume of the papers will be given to registered attendees and will also be available for sale from SME following the conference. Abstracts of the presentations are available in the NAT Showguide, bound into the back of this issue of Tunneling & Underground Construction.

Monday, June 25 — Four sessions are planned for the morning. They include "Roadheader and TBM preparation," chaired by T. Yokota of Frontier-Kemper; "Innovative solutions," chaired by J. Clare of MWH Global; "Contractural, Lifecycle and design focus," chaired by D. Day of DLZ; and "Better tunneling through knowledge and improvement of ground," chaired by P. Lydon of Hayward Baker.

Afternoon sessions on Monday will include "Mechanized tunneling," chaired by J. Rush of TBM Magazine;

"Analysis of soft ground tunnels," chaired by I. Halim of URS; "Project risk, cost and schedule," chaired by M. Vitale of Hatch Mott MacDonald; and "Trends and developments in mechanical excavation," chaired by J. Habimana of Parsons Brinckerhoff.

Tuesday, June 26 — Tuesday morning's program includes a case history track "Ground treatment," chaired by P. Schmall of Moretrench America; a design track, "Design and construction of large underground spaces," chaired by M. Kassouf of Triad Engineering; a planning session, "Project delivery and contracting strategies," chaired by M. Johnson of Halcrow and a technology session, "Applications of innovative technologies," chaired by P. Colton of Parsons.

Afternoon sessions include another case history track, "Microtunneling," chaired by A. Mekkaoui of Jay Dee Contractors; another design session, "Transit tunnel challenges," chaired by A. McGinn of Brierley Associates; "Geotechnical, environmental and sustainability challenges," chaired by L. Piek of Arup and "Applications and developments in TBM methods," chaired by C. Tan of GEI Consultants.

Wednesday, June 27 — The NAT technical program concludes Wednesday morning with four sessions. They include "Repair and rehabilitation," chaired by K. Yamauchi of Obayashi Corp.; "Dealing with underground water issues," chaired by J. McKelvey of Black & Veatch; "Future projects," chaired by A. Morgan of Jacobs Associates and "Monitoring, support and prediction," chaired by A. Marr of Geocomp.

Social events, field trip

In addition to Monday's NAT luncheon, the UCA of SME/ITA breakfast will be held Tuesday morning. The breakfast's program includes presentations from the winners of the Student Paper Contest. An exhibit hall luncheon on Tuesday and a reception later that afternoon are scheduled.

The UCA of SME Awards Banquet will take place Wednesday evening. Three industry professionals will be honored at the banquet, along with a project deemed Project of the Year.

Richard Lovat will receive the UCA of SME's Lifetime Achievement Award. He founded Lovat Inc. in 1972 to meet the industry's growing need for greater efficiency of tunneling operations.

The UCA's Outstanding Individual Achievement Award will be presented to James Marquardt, senior vice president and eastern region tunnel division manager with J.F. Shea Construction Inc. He began his career at 19 years old as a surveyor on a Washington, D.C. tunneling project. He now oversees the $1.1-billion New York City No. 7 Line subway extension project.

The exhibit at the 2012 NAT will include 116 industry supplying companies in 140 booths.

Edward Cording will receive the UCA's Outstanding Educator Award. He is professor emeritus of civil and environmental engineering at the University of Illinois at Urbana-Champaign. Cording has spent his career at the university and many of today's leaders in the tunneling and underground construction industry were once his students.

The UCA of SME's Project of the Year Award is the East Side Combined Sewer Overflow (ESCO) Tunnel project in Portland, OR. The project helps to reverse a century of river pollution and completes the city of Portland's 20-year effort to reduce sewer overflows into the Willamette River and Columbia Slough.

A field trip to Martin Marietta's North Indianapolis underground mine and quarry is scheduled for Wednesday afternoon at the conclusion of the technical part of the conference.

The North Indianapolis plant and quarry began operations during the 1950s as a sand and gravel operation. Today, the 243-ha (600-acre) operation produces more than 910 kt/a (1 million stpy) of crushed limestone from an openpit. The stone product from the North Indianapolis operation is used in highway and other development projects in the region surrounding Indianapolis.

RETC is next year

While it is still a year away, make plans to attend the Rapid Excavation and Tunneling Conference (RETC) June 23-26, 2013, scheduled to be held in Washington, D.C. Like NAT, the RETC will include an exhibit and a proceedings volume containing more than 100 presentations. ■

First pressurized TBM conference is a success

Having more than 200 tunneling and underground construction professionals in one room for two days will always generate some lively discussion.

Such was the case April 23 and 24 in Miami, FL when 238 pros from around the world gathered at the JW Marriott Hotel Miami for a new conference — Cutting Edge: Pressurized TBM Tunneling, sponsored by the *North American Tunneling Journal (NATJ)* and the Underground Construction Association of SME (UCA).

The 25 technical papers presented during the two-day meeting were of exceptional quality. Topics covered included project-specific approaches to tunnel boring machine (TBM) selection, procurement and operation, ground control, face support, monitoring, ground conditioning and slurry systems, TBM interventions and hyperbaric safety, research and development, and tunnel lining systems and annulus grouting.

Exhibit and field trip

In addition to the technical programming, 10 exhibiting companies showcased their products and services.

Exhibitors included American Chemical Technologies Inc., Ballard Diving and Salvage Hyperbaric SPPT, Baroid Industrial Drilling Products, BASF Construction Chemicals, Caterpillar Tunneling Canada Corp., Hayward Baker Inc., Herrenknecht Tunneling Systems USA Inc., The Robbins Co., Team Mixing Technologies Inc. and W.R. Grace & Co.

Prior to the meeting, some of the participants were able to visit the Port of Miami Tunnel project. This $900-million project is one of North America's most technically challenging pressurized TBM project. It includes a 1.1-km- (0.75-mile-) long twin-tube highway tunnel that will connect the MacArthur Causeway on Miami's Watson Island to the Port of Miami on Dodge Island. The tunnel is being excavated using a 12.5-m- (24-ft-) diameter Herrenknecht mixshield TBM.

Technical program

The 25 technical paper presented were split into six sessions. Two panel discussions were presented at the end of each day. The sessions were recorded and will be made available to attendees.

The first session on Monday morning was "Pressurized TBM tunneling — Pushing the envelope," chaired by Rick Lovat of L2 Advisors. Papers included "The Port of Miami Tunnel," "Alaskan Way bored tunnel" and "Selection criteria for pressurized TBM projects (slurry versus EPB)."

Steve Kral, Editor

The second session Monday was "Ground control, face support and monitoring," chaired by Derek Zoldy of AECOM Canada. Papers included "Continuous face support with large diameter TBMs," "EPB pressure settings: A contractor's perspective," "Face losses on the Beacon Hill Tunnel" and "Global real time monitoring during compensation grouting works at the Schulich Executive Center (Spadina Subway Northern Extension, Toronto)."

The final session on Monday was titled "Ground conditioning and TBM control systems," chaired by Niels Kofoed of Kiewet Infrastructure. Papers included "Muds and foams 101," "Ground conditioning: Before the boring," "Practical soil conditioning: Optimizing TBM performance," "Effective interpretation of TBM data acquisition" and "Accuracy and means of improving measurement of muck volumes."

Tuesday's sessions began with "Innovations in TBM technology," chaired by Jon Hurt of ARUP. Papers included "Maintenance, wear and operational experience: Going the distance on long EPBM tunnel drives, the Brightwater West and BT3 C projects," "Cutterhead and material flow research and development," "Making short work of mixed ground: How to keep your EPB moving," "Developments in metallurgy and cutter tool design" and "Latest developments in hybrid machines."

The second session on Tuesday was called "Compressed air TBM intervention and hyperbaric safety," chaired by Colin Lawrence of Hatch Mott MacDonald. Papers included "U.S. hyerbaric tunneling codes and standards," "International guidance for HPCA interventions," "TBM interventions and chamber access" and "Manned interventions for Alaskan Way Viaduct, Port Mann and Lake Mead."

The final of the TBM conference was titled "Tunnel lining systems," chaired by Robert Goodfellow of Aldea Services. Papers included "Tunnel lining design: The devil is in the details," "Modern steel fiber sesgment production in the U.K.," "Segmental liner manufacturing in North America" and "Integration of seals and connectors into precast tunnel segment design."

NATJ donation

The North American Tunneling Journal plans to donate 10 percent of its share of profits from this successful meeting to the UCA of SME's new student scholarship fund. These funds will be used to sponsor students whose studies specialize in the underground construction industry. ■

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
Gateway Tunnel project	Amtrak	Newark	NJ	Subway	14,600	24.5	2015	Under study
2nd Ave. Phase 2-4	NYC-MTA	New York	NY	Subway	105,600	20	2012-20	Under study
Water Tunnel #3 bypass tunnel	NYC-DEP	New York	NY	Water	20,000	22	2015	Under design
Water Tunnel #3 Stage 3 Kensico	NYC-DEP	New York	NY	Water	84,000	20	2017	Under design
Cross Harbor Freight Tunnel	NYC Reg. Develop. Authority	New York	NY	Highway	25,000	30	2016	Under study
Silver Line Extension	Boston Transit Authority	Boston	MA	Subway	8,400	22	2014	Under design
Hartford CSO program	MDC	Hartford	CT	CSO	32,000	20	2013	Under design
South Conveyance Tunnel	City of Hartford	Hartford	CT	CSO	16,000	26	2014	Under design
Red Line Tunnel - Phase 1	Baltimore DOT	Baltimore	MD	Subway	9,600	23	2015	Under design
Red Line Tunnel - Phase 2	Baltimore DOT	Baltimore	MD	Subway	32,000	23	2015	Under design
WASA CSO Program Anacostia River Tunnel Northeast Branch Tunnel Northeast Boundry Tunnel Virginia Ave. Tunnel Expan. Dulles Silver Line Phase 2	DC Water and Sewer Authority CSX Railroad WMATA	Washington	DC	CSO CSO CSO Rail Subway	12,500 11,300 17,500 4,000 Various	23 15 23 40 20	2013 2018 2021 2013 2014	Under design Under design Under design Under design Under study
ISCS Dekalb Tunnel	Dekalb County	Decatur	GA	CSO	26,400	25	2013	Under design
Olentangy Relief Sewer Tunnel	City of Columbus	Columbus	OH	Sewer	58,000	14	2013	Under design
Alum Creek Relief Sewer Tunnel	City of Columbus	Columbus	OH	Sewer	74,000	10 - 18	2014	Under design
Black Lick Tunnel	City of Columbus	Columbus	OH	Sewer	32,000	8	2013	Under design
Dugway Storage Tunnel	NEORSD	Cleveland	OH	CSO	16,000	24	2014	Under design
Doan Valley Storage Tunnel	NEORSD	Cleveland	OH	CSO	9,700	17	2015	Under design
Westerly Main Storage Tunnel	NEORSD	Cleveland	OH	CSO	12,300	24	2020	Under design
Lower Mill Creek CSO Tunnel - Phase 1	M.S.D. of Greater Cincinnati	Cincinnati	OH	CSO	9,600	30	2013	Under design
Lower Mill Creek CSO Tunnel - Phase 2	M.S.D. of Greater Cincinnati	Cincinnati	OH	CSO	1.500	30	2015	Under design
Ohio Canal Tunnel	City of Akron	Akron	OH	CSO	5,500	25	2014	Under design
Northside Tunnel	City of Akron	Akron	OH	CSO	10,000	20	2022	Under design
ALSCOSAN CSO Program	Allegheny Co. Sanitary Authority	Pittsburgh	PA	CSO	35,000	30	2016	Under design

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
Pogues Run Tunnel	Indianapolis DPW	Indianapolis	IN	CSO	11,000	18	2013	Under design
Pleasant Run Deep Tunnel	Indianapolis DPW	Indianapolis	IN	CSO	34,000	18	2015	Under design
Fall Creek Tunnel	Indianapolis DPW	Indianapolis	IN	CSO	27,000	18	2015	Under design
White River Tunnel	Indianapolis DPW	Indianapolis	IN	CSO	19,000	18	2015	Under design
Drumanard Tunnel	Kentucky DOT	Louisville	KY	Highway	2,200 x 2	35	2012	Bidders qualified
St. Louis CSO Expansion	St. Louis MSD	St. Louis	MO	CSO	47,500	30	2014	Under design
North Link Light Rail Extension	Sound Transit	Seattle	WA	Transit	35,000	22	2014	Under design
East Link Light Rail Extension	Sound Transit	Seattle	WA	Transit	30,000	21	2016	Under design
Chinatown NATM Station	San Fran. Muni Transit Authority	San Francisco	CA	Subway	340	60	2012	Bid date 06/05/12
Third Ave. Subway Tunnel	San Fran. Muni Transit Authority	San Francisco	CA	Subway	10,000	22	2013	Under design
San Francisco DTX	Transbay Joint Powers Authority	San Francisco	CA	Transit	6,000	35 to 50	2012	Under design
L.A. Metro Regional Connector	Los Angeles MTA	Los Angeles	CA	Subway	20,000	20	2012	Under design
LA Metro Wilshire Extension Phase 1 Phase 2 Phase 3	Los Angeles MTA	Los Angeles	CA	Subway	42,000 26,500 26,500	20 20 20	2013 2014 2016	Under design Under design Under design
LAX to Crenshaw	Los Angeles MTA	Los Angeles	CA	Subway	12,200	20	2012	Under design
LA CSO Program	L.A. Dept. of Public Works	Los Angeles	CA	CSO	20,000	14	2014	Under design
Freeway 710 Tunnel	CALTRANS	Long Beach	CA	Highway	26,400	38	2016	Under design
SVRT BART	Santa Clara Valley Trans. Authority	San Jose	CA	Subway	22,700	20	2014	Under design/ delayed
BDCP Tunnel #1	Bay Delta Conservation Plan	Sacramento	CA	Water	26,000	29	2014	Under design
BDCP Tunnel #2	Bay Delta Conservation Plan	Sacramento	CA	Water	369,600	35	2016	Under design
Kaneohe W.W. Tunnel	Honolulu Dept. of Env. Services	Honolulu	HI	Sewer	15,000	13	2012	Under design
Eglinton West Tunnel	Toronto Transit Commission	Toronto	ON	Subway	40,500	18	2012	Cancelled
Yonge Street Extension	Toronto Transit Commission	Toronto	ON	Subway	15,000	18	2015	Cancelled
Hanlan Water Tunnel	Region of Peel	Toronto	ON	CSO	19,500	12	2013	Under design
Downtown LRT Tunnel	City of Ottawa	Ottawa	ON	Transit	21,000	18	2012	Prequalified JV's announced
Second Narrows Tunnel	City of Vancouver	Vancouver	BC	CSO	3,600	14	2013	Under design
Evergreen Line Project	Trans Link	Vancouver	BC	Subway	10,000	18	2012	Prequalified JV's announced

UCA of SME Sustaining Members

The UCA of SME wishes to thank our Corporate and Sustaining Member companies. Their support for the underground construction industry and its professionals, is sincerely appreciated.

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MWH Global

Hauser joins UCA Executive Committee

Gregory M. Hauser will join the Executive Commttee of the Underground Construction Association (UCA) Division of SME during the North American Tunneling Conference on June 24, 2012. The committee also welcomes returning members Heather Ivory, Art Silber and Rick Lovat.

Gregory M. Hauser

Gregory M. Hauser, P.E., recently joined Dragados USA as its lead on the Alaska Way Viaduct Replacement project in Seattle, WA. From 2001-2012, he worked for Jay Dee Contractors, headquartered in Livonia, MI.

Hauser was the project manager on the Brightwater West and BT3C contracts for King County, WA and the West Coast Area manager for Jay Dee. He participated in the bids for all of the Brightwater projects and worked on the Brightwater tunnels in King County since 2006.

Hauser said that the success of the Brightwater West and BT3 C projects has been the highlight of his career, but that he has now begun a new chapter with Dragados.

HAUSER

Hauser is a 1971 graduate of Michigan Technological University and is a licensed professional engineer in Michigan, New York and Illinois. He has been in the underground construction business, working for various general contractors, since 1973 and has worked on several projects in Michigan and Illinois.

Hauser also worked on four tunnel projects in Rochester, NY; on the super conducting super collider in Waxahachie TX; on the Metro Green Line's 14th Street tunnels and the Park Road tunnels projects in Washington, D.C.; the Los Angeles, CA MTA projects for the Hollywood and Vine and the North Hollywood Stations; and, briefly, in Boston for Modern Continental on the Braintree Weymouth tunnel project.

Prior to coming to Seattle, Hauser was the project manager for Jay Dee Affholder JV on the Little Calumet tunnels and shafts project for the Metropolitan Water Reclamation District of Greater Chicago. ■

BRIERLEY SCHOLARSHIP

Crump and Goertz receive Brierley scholarships

The UCA of SME awarded $900 Brierley scholarships to Charles Emery Crump and Benjamin Goertz at the February UCA student chapter meeting at the Colorado School of Mines (CSM).

Crump is a senior majoring in mining engineering from Rocky Ford, CO. He is the current president of the UCA of SME student chapter at CSM. He works part time for the Earth Mechanics Institute at CSM and plans to graduate in December 2012.

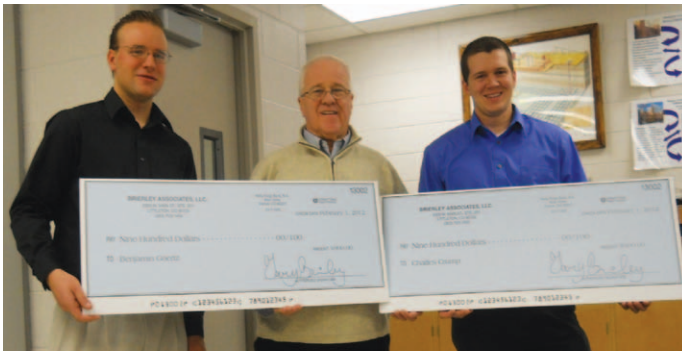
Goertz is a senior majoring in mining engineerings from San Antonio, TX. He is the current vice president of the UCA student chapter. He graduated in May and plans to continue his studies to obtain a master's degree in mining and earth systems engineering.

Brierley Associates hopes to continue awarding scholarships each year to qualified students who are student members of the UCA of SME and who show an interest in tunneling and underground construction.

Ray Henn, senior consultant with Brierley, presented the scholarships. He is the UCA student chapter faculty advisor and is an adjunct professor at CSM.

David Kwietnewski, a senior project engineer with Brierley Associates in Littleton, CO, spoke to the student chapter meeting on the construction of the fourth bore of the Calecott Tunnel. ■

Benjamin Goertz (l) and Charles Crump (r) received scholarship checks from Ray Henn (c) of Brierley Associates.



UCA presents three awards at NAT

Outstanding Educator Award to Edward Cording

The UCA of SME's Outstanding Educator Award is presented by the UCA Executive Committee to professors and teachers who have had an exceptional career in academia and education in the areas of underground design and construction. These individuals also have made significant contributions to the industry through their academic interests, as well as through the introduction of many student graduates into the industry. They are nominated by their peers.


CORDING

Edward Cording is professor emeritus of civil and environmental engineering at the University of Illinois, Urbana-Champaign. There, he taught and conducted research in geotechnical engineering, focusing on rock engineering, soil-structure interaction and underground construction. He currently teaches a graduate-level case studies course in tunneling.

Cording directed university field research on the first subway tunnels and stations constructed on the Washington, D.C. Metro, monitoring the stability of station caverns in rock and ground deformations and loads for braced excavations and tunnels in soil. For the past 45 years, he has been a geotechnical consultant on excavation and tunneling projects for buildings, highways, dams, mines, water supply, high energy physics, nuclear waste disposal, gas storage caverns, sewer and rail.

Cording has been engaged on transit projects in Washington, D.C., Philadelphia, PA, Boston, MA, Atlanta, GA, Seattle, WA, Toronto, ON, Canada, San Francisco, San Jose and Los Angeles, CA and San Juan, PR. In New York, he consulted on the design and construction of the Second Avenue Subway stations and tunnels, the East Side Access tunnels and caverns beneath Grand Central Terminal, Trans Hudson Express EPB tunnels and caverns to Penn Station, and MTA No. 7 Line Extension tunnels.

From 1991 to 1997, Cording had a presidential appointment to the U.S. Nuclear Waste Technical Review Board reviewing siting for the Yucca Mountain high-level, underground nuclear waste facility. He recently served on the Large Cavity Advisory Board for the siting and design of neutrino caverns for the Deep Underground Science and Engineering Laboratory at the Homestake gold mine in South Dakota.

His current projects include the SR 99 viaduct replacement highway tunnel, to be driven with an earth pressure balance TBM beneath downtown Seattle; the Transbay transit terminal excavation in downtown San Francisco; and the DC Water Blue Plains and Anacostia River tunnels. He is a member of the tunnel advisory panel for the Los Angeles Metro.

Cording was elected a member of the National Academy of Engineering in 1989, received the American Society of Civil Engineers' (ASCE) Martin S. Kapp Award and received the Moles nonmember award for Outstanding Achievement in Construction in 2003. He gave the ASCE Metropolitan Section William B. Parsons lecture in 2005 and received the Geo Institute Harry Schnabel Jr. Award for Career Excellence in Earth Retaining Structures in 2007. ■

Lifetime Achievement Award to Richard Lovat

The UCA Lifetime Achievement Award recognizes outstanding achievements in the underground design and construction industry. The outstanding achievements recognized have been accomplished through the design or construction of civil underground facilities.


LOVAT

Richard Lovat worked as a miner in his home country, Italy, and as an electrician in Switzerland before immigrating to Canada in 1952. In Canada, he worked for general and tunneling contractors in the Montreal and Toronto areas until 1972. He then founded Lovat Inc. to meet the growing need for greater efficiency of tunneling operations and acquired the facilities of the manufacturing plant in Toronto. His company employed 12 individuals.

From 1972 to 2009, Lovat was the president, and then chair, of Lovat Inc. In the span of 37 years, Lovat increased the company's manufacturing capacity by a 3,000-m² expansion, employed a staff of more than 400 people, established a European sales and service office in London, an office in Singapore for Asia and an office in Sydney for Australia. He entered the *Guinness Book of World Records* for the fastest tunnel drilling equipment in the world and manufactured more than 250 tunnel boring machines for more than 700 tunneling projects worldwide.

Between 1974 and 1988, Lovat developed patented methods of increasing productivity and maximizing safety for tunnel workers, such as a ripper assembly, a rib expander, device for erecting a segment tunnel wall lining and a head intake for a tunneling machine. In April 2008, Lovat Inc. was sold to Caterpillar.

Lovat is retired. He and his wife travel between his home in Etobicoke, ON, Canada and Italy. ■

Outstanding Individual Award to James M. Marquardt

The Outstanding Individual Award recognizes those individuals who have made significant contributions to the field of tunneling and underground construction and to UCA.

James M. Marquardt is a senior vice president with J.F. Shea Construction. He has been with Shea Construction for 25 years, and he was project manager for Shea from 1987 to 2005. Marquardt has worked in the industry for 40 years. Prior to joining Shea, he worked for Morrison Knudsen, Gates & Fox Co. and the Clevecon Corp.

Currently, Marquardt is managing Shea's Eastern Area Tunnel Division and is the project director of the No. 7 Line subway, New York City, NY. The No. 7 Line Extension project consists of mining two 1,463 m- (4,800 ft-) long rock tunnels using two tunnel boring machines and lined with one-pass precast concrete segments. It includes one underground station structure approximately 366 m-(1,200 ft-) long, excavated by conventional rock excavation methods and concrete lined. Also included is existing tail tunnel retrofitting, invert lowering and railroad structure underpinning.

His past project management has included the $320 million New York City Water Tunnel No. 3, Stage II and the $150 million Weehawken Tunnel Light Rail Transit project in New Jersey. He has also managed major projects on the Washington D.C. Metro and Los Angeles Metro, along with major water tunnel projects on the East Coast.


MARQUARDT

Marquardt has recently served the Moles as a trustee on its Executive Committee and as vice chair of the Awards Committee. He was a member of the RETC Executive Committee and chair of the 2009 conference. He was also a member of the Executive Committee of the General Contractors Association of New York and a trustee of the Associated General Contractors of New Jersey. In January 2012, he received the Supervision Award from the Beavers. ■

Project of the Year award to the East Side Combined Sewer Overflow tunnel project

The Project of the Year Award recognizes an individual or a group that has shown insight and understanding of underground construction in a significant project, which may include a practice, developing concepts, theories or technologies to overcome unusual problems within a project.

The East Side Combined Sewer Overflow (ESCSO) tunnel project is the largest public works project in the history of Portland, OR. The project owner is the Bureau of Environmental Services (BES).

The project completes the city's 20-year commitment to Oregon to significantly reduce combined sewer overflows into the Willamette River and Columbia Slough from the city's CSO system. It helps reverse a century of river pollution. And its far-reaching benefits contribute to a greater livability and a healthier future for Portland, its residents and its river.

The project included 8,839 m (29,000 ft) of 6.7-m (22-ft) internal diameter tunnel, seven large-diameter shafts to depths of up to 55 m (180 ft) and 3,048 m (10,000 ft) of diversion pipelines with hydraulic structures to collect, store and convey CSOs to a pump station for transfer to the city's wastewater treatment plant.

The tunnel was constructed at depths ranging from 24.4- to 48.8-m (80 to 160-ft) deep through difficult soft ground conditions com-

The cutterhead is being lowered into the Opera Shaft, one of the seven shafts that were built along the alignment. The shafts connect existing overflow pipes to the East Side CSO Tunnel and provide above ground access to the tunnel.

Opera shaft's cutterhead dedication ceremony.

prised of a mix of gravel, cobble and boulders in a sand/silt matrix and through channels incised into these coarse gravels and in-filled with soft sediments. It was excavated using a slurry mix-shield tunnel boring machine and lined with a one-pass gasketed segmented precast concrete tunnel lining. More than 85 percent of the alignment used steel fiber-reinforced concrete segments as a final tunnel lining — one of the first uses in the United States.

For the ESCSO tunnel project, BES used an alternative contracting strategy. This approach was originally introduced on the West Side CSO tunnel project to minimize, if not eliminate, claims and disputes and to ensure a timely, cost-effective, well-built project by aligning the objectives of the owner, designer and contractor. It uses a qualifications-based process to select a contractor at approximately the 60 percent design stage, starts with a preconstruction planning phase, which is followed by fixed-fee cost-reimbursable contract to carry out the work. This contracting method provided the contract flexibility and team building approach that delivered Portland's largest public-works program on time and under budget, while maintaining effective quality control and worker safety program. The contract approach resulted in a project delivered on time and with savings to the city of more than $70 million on the 2006 budget of $471 million.

Design for the project was carried out by a team led by Parsons Brinckerhoff, which also provided technical support during construction. BES has acted as its own construction manager, supported by staff led by Jacobs Associates. A joint venture of Kiewit/Bilfinger Berger served as the prime contractor. ■

PERSONAL NEWS

Jacobs Associates has promoted **ISABELLE LAMB, GREGG DAVIDSON** P.E., C.Eng (SME), **DAN DOBBELS,** P.E. and **MARK HAVEKOST**, P.E. to the position of Principal.

DAVIDSON

Davidson has worked in the firm's Seattle office since 2003. He has 24 years of experience in the design, program and construction management of tunnel and underground projects. This includes transportation, water and wastewater conveyance and hydropower schemes, using various types of excavation methods. He is currently the project manager for the Gorge 2nd Hydropower Tunnel project and works full time on the final design phase of the North Link Light Rail project. He also serves as a vice president of Jacobs Associates Canada.

Lamb is an engineering geologist based in Seattle and currently serves as project manager for the North Link Light Rail project and project director for NTP JV in the ongoing design support of the University Link Light Rail project. She joined Jacobs Associates in 2003 and is a vice president of Jacobs Associates New Zealand.

Dobbels is the project manager for the Ottawa Light Rail Transit project and vice president of Jacobs Associates Canada. He joined the company's Boston office in 2009.

Havekost currently leads the engineering teams on several hydropower projects, including the Lower Baker Unit 4 Powerhouse, the Gorge 2nd Hydropower Tunnel and the Boundary Dam Rockfall Mitigation project. He joined Jacobs Associates in 2000 and opened the firm's Portland office in 2007, where he has been involved in design and construction of several underground components of the City of Portland's CSO Program.

BRADFORD TOWNSEND, P.E. (SME) has joined Parsons Group as a vice president in its Bridge and Tunnel Division. He is responsible for the technical direction and management of alternative project delivery. Prior to joining Parsons, Townsend served as west region deputy practice manager tunnels – senior associate for an engineering firm in California. He served as deputy chief engineer of the $20 billion Taiwan high-speed rail project, as well as leadership roles on the Hai Van Pass tunnel construction project in Vietnam.

TOWNSEND

CHRIS SIVESIND has joined Akerman's sales and marketing team. Most recently, he worked for The Robbins Co. as a sales engineer for boring equipment. ■

September 2012

18-21, InnoTrans 2012, Berlin, Germany, Contact: Messe Berlin GmbH, Messedamm 22, 14055 Berlin, Germany, InnoTrans Team, fax: 49-0-30-30 38-21-90, e-mail innotrans@messe-berlin.de.

19-21, Colorado School of Mines Tunnel Short Course, Colorado School of Mines, Golden, CO, Contact: Levent Ozdemir, 780 Kachina Circle Golden, CO 80401, phone: 303-526-1905, 303-999-1390, e-mail lozdemir1977@aol.com, website www.csmspace.com.

October 2012

17-20, Tunneling Association of Canada Conference, Hyatt Hotel, Montreal, Quebec, Canada. Contact: Wayne Gibson, conference manager, Gibson Group Association Management, 8828 Pigott Rd. Richmond BC V7A 2C4, phone 604-241-1297, fax 604-241-1399, e-mail info@tac2012.ca, www.tac2012.ca.

More meetings information can be accessed at the SME website — http://www.smenet.org.

16-19, 37th Annual Conference on Deep Foundations, George R. Brown Convention Center, Houston, TX. Contact: Deep Foundations Institute 326 Lafayette Ave. - Hawthorne, NJ 07506, phone 973-423-4030; fax: 973-423-4031, e-mail, staff@dfi.org, website www.dfi.org.

17-20, Montreal TAC 2012 - Hyatt Regency Hotel, Montreal, Quebec, Canada. Contact: Wayne Gibson, conference manager, phone 604-241-1297, e-mail info@tac2012.ca, www.tunnelcanada.ca.

November 2012

12-14, 30th International No-Dig, Sao Paulo, Brazil. Contact: Benjamin Media Inc., 1770 Main St, PO Box 190, Peninsula, OH 44264, USA; phone: 1-330-467-7588, fax: 1-330-468-2289, e-mail kduresky@benjaminmedia.com, website www.istt.com

June 2013

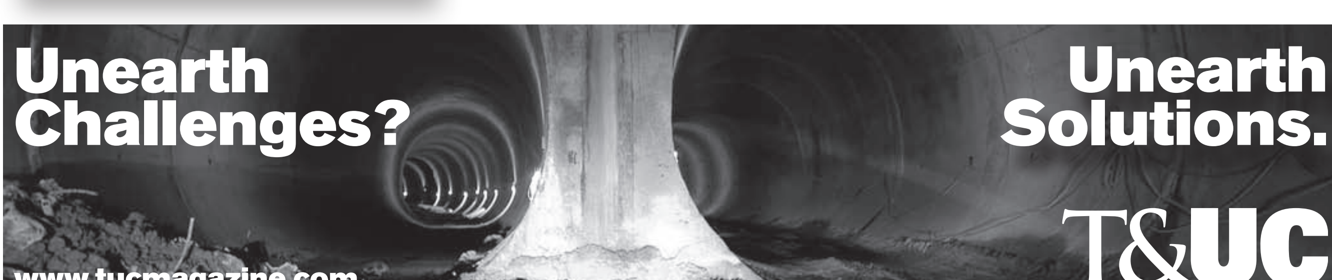
23-26, RETC 2013, Washington, D.C. Contact: Meetings Dept., SME, 12999 East Adam Aircraft Circle, Englewood, CO 80112, , phone 800-763-3132 or 303-948-4280, fax 303-979-3461, e-mail sme@smenet.org, Web site www.smenet.org. ■

UTT REPRESENTATIVE NORTH AMERICA

MAPEI, a global leader of construction chemicals, admixtures and concrete restoration products, is currently seeking a UTT Representative for North America. This UTT Representative will manage all product sales and provide the necessary site support for the tunneling and mining product range throughout North America. Assist customer base with bid numbers to include MAPEI UTT Products. Develop, grow, and manage relationships and supply contracts with key construction firms specializing in tunneling and/or mining operations. Develop partnerships with key TBM equipment and product manufacturers. A solid understanding of concrete admixtures, mix design, shotcrete, grouting, and waterproofing products will be required. This position will require the ability to travel, work flexible hours to meet customer and project demands, and to perform other ad hoc duties as assigned by manager. Successful candidates must have a Bachelor's degree (B.S.) from a four-year College/University or the equivalent work related experience in the tunneling and mining industries.

Interested candidates should send their resume along with salary history/requirements to:
Kevin Smith (kesmith@mapei.com)

For more info, please visit us at: http://www.mapei.com



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