T&UC
TUNNELING & UNDERGROUND CONSTRUCTION
THE OFFICIAL PUBLICATION OF UCA OF SME WWW.TUCMAGAZINE.COM VOLUME 3 NO 2 JUNE 2009

# RETC 2009 IN LAS VEGAS

## Deep Shaft Freezing at Brightwater

## Tunnel Demand Forecast

Special Editorial Section from the publisher of *Mining Engineering*

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## FEATURE ARTICLES







DEPARTMENTS

## CHAIRMAN'S COLUMN

# UCA —two year update

This is my last column as Chair as I will be handing over the chair's gavel to David Klug at our Executive Committee meeting on the last day of the Rapid Excavation and Tunneling Conference (RETC). It has been a quick two-year stint but I had a great time working with all of you. We have worked to take advantage of the firm footing of UCA and the support of SME to further our purpose and continue to reach deeper into the organization to engage the members in our many activities. The UCA now has two conference planning committees for our standing conferences: the North American Tunneling Conference (NAT), held every other year, and the annual George A. Fox Conference, that began as the New York Regional Tunneling Conference. In addition to these standing conferences, we often sponsor specialty and topical workshops or other regional tunneling conferences. These support owners embarking on a tunneling campaign and benefit from our industry's network of suppliers, engineers, contractors and owners. The recent Seattle Regional Tunnel Conference held on May 4, is such an example (see page 5). At that conference, the UCA sponsored a one-day forum to provide a networking venue where updates on past and ongoing tunneling projects were discussed. Lessons learned and recurring issues related to contracting that require attention early in the project development and design phases were also discussed. I would like to thank those who contributed to the success of the Seattle conference, including conference presenters and our generous sponsors and the attendees. Presentations and the list of attendees will be posted on the UCA Web site (www.uca.smenet.org).

I would like to recap some additional developments from the last two years. We have re-established our financial footing and we are now programming the use of some of these assets to provide additional opportunities for your involvement, including the funding of a UCA scholarship program and the student paper competition that pays for the registration and travel expenses to NAT for the competition finalists. The executive committee also has approved two new committees: Concrete Specifications for Underground Construction, and Tunnel Rehabilitation. In addition, we are developing an education and training program. One of our first short courses will be on shaft design and construction, scheduled for Sept. 10 and 11, 2009 in Atlanta, GA. Information is available on the UCA Web site.

The Benefits of Going Underground Committee has been active in putting together an excellent presentation that captures the many uses as well as our industry's contributions to sustainability. This presentation is informative, comprehensive and will be available on the UCA Web site should you need to address local communities, community leaders, politicians or school children. I used this presentation to address Penn State students in mining and engineering and to describe the number of career opportunities available in the world of underground design and construction.

UCA is currently a division of the Society for Mining, Metallurgy and Exploration and we are inspiring the other divisions. We currently represent 5 percent of the total membership of SME, yet provide 8 percent of the average operating revenue of SME. Unlike most divisions, we host separate and industry specific conferences, workshops and have a separate magazine, all of which contribute to our total revenue stream. We also maintain a separate brand of UCA, including separate Web site, although it is linked with SME.

This year, and rather last min-

Continued on page 12

**Brenda Bohlke,**
**UCA of SME Chairman**

# I am SME.

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# Alaskan Way viaduct replacement project discussed at Seattle Regional Conference

Approximately, 250 tunneling and underground professionals attended Seattle Regional Tunneling Conference on May 4 to hear the latest development and approval of the large bore tunnel to replace the Alaskan Way Viaduct, as well as the latest progress reports from the Sound Transit Tunnel and Brightwater Conveyance tunnels in King County, WA. The day's program, organized by the UCA of SME, built on the story and history of tunneling in the Seattle area along with the description of the complex glacial deposits, seismic setting and backfilling of the harbor, burying the first floor of many of the buildings along the former waterfront and what now is First Avenue. John Harrison provided the latest update on the Beacon Hill Tunnels and the recent selection of the contractor for the University Link. Sound Transit has successfully completed numerous miles of tunnels, using pressure faced machines for the running tunnels and SEM for the station excavation at Beacon Hill. Judy Cochran, construction manager for King County, provided the context and lessons learned from the Brightwater Conveyance tunnel construction and reminded the audience that "it is not what you anticipate, but what you did not anticipate that can slow any job, and it all comes down to relationships and communications at all levels and among all parties".

Speaking of the Alaskan Way Viaduct replacement project, Washington State Department of Transportation (WSDOT) and the city of Seattle, represented by Ron Paananen and Bob Powers, respectively, provided a recap of how the decision to proceed with the single large bore tunnel came to be the reality in a short time frame and the sudden reversal of direction from the governor's office as a consequence of the engagement and support of the local community leaders. John White, later in the program, described the project, its alignment and physical attributes that consist of a 16-m (54-ft) diameter tunnel set at depth below the First Avenue with a south portal in the vicinity of the port and the stadia. The tunnel



will convey two levels of opposing traffic, each level having two lanes and a wide shoulder. Emergency egress chambers are also contained within the tunnel as currently dimensioned.

In the late morning session, reports on many of the successful large bore tunnels from around the world were heard, including the Madrid M 30, the Barcelona Tunnels, The SMART Tunnel in Malaysia, Shanghai, Bund tunnels in Mexico City and Sir Adam Beck tunnels to name a few. The focus was on large diameter, and pressure face machines. Most of these were accomplsihed in an urban environment and in a complex geology and high water pressure.

In the afternoon, two panels expressed opinions about the new Alaskan Way large bore tunnel. The community perspective's panel reinforced the significance of the role of the community leaders and business stakeholders and their active engagement with other state officials. Surveys of business along the waterfront indicated that the losses resulting from the impact of construction of a new elevated or surface highway along the waterfront would cost more in financial losses than the estimated cost of the tunnel. In addition, the environmental impacts were also less for the tunnel alternative. WSDOT and the local community stakeholders continue their interactive dialogue as the design gets underway to assist in planning and design of the tunnel portal areas and the interchanges and connections to surface streets at north and south ends of the tunnel.

A second panel, consisting of an array of tunnel industry representatives, including tunnel boring machine (TBM) manufacturers, contractors, legal, labor, engineers and owners points' of view, resulted in a lively discussion of opportunities and issues to be considered during advancement of the design and contracting methods for the large bore tunnel.

The Alaskan Way Viaduct replacement tunnel is on a fast track with a target date of December 2015 for the tunnel to be open to traffic. This means that WSDOT is aggressively managing the design and the strategy to package and procure the tunnel contractor. To take advantage of the UCA tunneling conference, WSDOT held an early contractor forum specifically on the large bore to solicit further comments. A second forum is expected in June with firmer dates and decisions on the contracting schedule and strategy. ■

# Governor signs Alaska Way viduct replacement legislation

Seattle Mayor Greg Nickels and Washington Gov. Chris Gregoire signed legislation on May 12 to officially replace the Alaskan Way Viaduct with a $4.2 -billion deep bore tunnel.

Officials have been wrangling over how to replace the viaduct since the 2001 Nisqually earthquake critically damaged the 1950s-era double-deck roadway, which carries 110,000 vehicles a day, *Seattle Post Intelligencer* reported on its Web site.

Seattle, King County and state elected officials agreed on the deep-bore tunnel replacement in January, despite the fact that state leaders previously had deemed a tunnel as too expensive and Seattle voters soundly rejected a cut-and-cover tunnel and a new viaduct in a 2007 ballot measure.

Supporters said advances in deep-bore technology now allow for replacing the viaduct with a single double-deck tunnel, rather than twin tunnels, with less disruption than a cut-and-cover tunnel, because the viaduct could remain open during construction. Supporters also say the plan will reconnect Seattle to the waterfront while maintaining traffic capacity through downtown.

The legislature approved the tunnel bill last month. Gregoire and Nickels had about 30 city, county and state officials around them for the signing and many more tunnel supporters in the audience, and servers popped champagne corks during the ceremony in preparation for a toast after the signing.

The signing is "a major victory for downtown Seattle, for the region and for the state," Downtown Seattle Association President Kate Joncas said in a statement. "The tunnel will reconnect downtown to our waterfront, will reshape the front porch to our city and will maintain mobility for people and goods through and within downtown."

After the signing, Gregoire said the deep-bore tunnel is much different from the cut-and-cover plan voters rejected.

The final tunnel legislation included an amendment requiring property owners in Seattle to pay for cost overruns beyond the $2.8 billion the state has allocated for it. But legal experts have expressed doubt the provision is enforceable. ■

# Big Dig charges against Modern Continental Construction dropped

Charges against Modern Continental Construction Co. Inc., related to the Big Dig project tunnel collapse that killed a Boston, MA woman were dropped by federal prosecutors, but the company pleaded guilty to lying about construction defects in another tunnel, the *Associated Press* reported.

Modern Continental Construction Co. Inc. pleaded guilty to 39 counts of making false statements in connection with a highway project.

The company acknowledged that some of its field employees knew about poor workmanship on a slurry wall panel in Interstate 93's Tip O'Neill Tunnel before portions of the wall blew out in 2004, causing water to rush into the tunnel and creating a major traffic problem.

The company certified that the panels were built to specifications when they were not.

Modern Continental also acknowledged that it overbilled the Big Dig by falsely charging higher journeyman rates for work really done by apprentices.

However, prosecutors agreed to dismiss the most serious charges against the company, related to the government's allegation that the company knowingly used the wrong type of adhesive to hold up concrete anchors that failed in the collapse of the Interstate 90 connector tunnel in July 2006.

In a court filing, acting U.S. Attorney Michael Loucks said the dismissal of some of the charges against Modern Continental "is in the interests of justice."

Modern Continental President John Pastore entered the guilty pleas on behalf of the company. He declined to comment after the hearing.

The company's lawyer, Michael Connolly, said Modern is pleased with the resolution of the criminal case but regrets submitting false statements about work on the slurry wall and overbilling the project.

Connolly said the overbilling amounted to about $12,000 per year over 15 years while the company performed more than $3 billion worth of work on the massive highway project. ■

# Boring at the Samur-Apsheron irrigation project will begin in summer 2009

For centuries, a lack of surface water has led to intensive use of ground water for irrigation in Baku, Azerbaijan. The Samur-Apsheron irrigation project will help remedy current water problems by overhauling a main canal that provides water supplies to Baku. New tunnels will be built using a 6.3-m- (20.7-ft-) diameter Robbins earth pressure balance (EPB) machine — the first-ever tunnel boring machine (TBM) to be used in Azerbaijan.

Contractor Azerkorpu awarded Robbins the contract for the complete EPB boring system in June 2008, which includes the backup, cutting tools, segment molds, segment manufacturing plant, rolling stock, ventilation system, spares and operating personnel. Major components of the machine including the main bearing, electrical, and hydraulic systems were procured in the U.S., Europe and Japan. Assembly of the EPB was completed in April 2009 by the Robbins EPB Division in Guangzhou, China.

The TBM is slated for a summer 2009 launch and is expected to bore for eight to nine months in hard clay, silt, sand and mixed-face rock. The machine features a mixed ground cutterhead with interchangeable disc cutters and carbide bits. Four independent foam injection points in the cutterhead evenly consolidate the face in varying ground conditions. Multiple detection systems provide electronic information about clogged ports, preventing unnecessary cutter and cutterhead wear.

The machine will excavate one tunnel of approximately 3.5 km (2.2 miles). As the TBM bores, it will line the tunnel with 300-mm- (12-in.-) thick precast concrete, universal type segments in a 5+1 arrangement. Once the tunnels are complete in 2010, Azerkorpu plans to use the EPB on several other projects in the country.

The Samur-Apsheron irrigation project, for the Azerbaijan government's irrigation department, consists of open canals and TBM-driven tunnels totaling 5.7 km (3.5 miles) in length. The network will convey water from the Samur River to use for both irrigation and the new Takhtakerpu hydropower station, which will provide power to the Cusar District in Baku. ■

**The 6.3 m (20.7 ft) Robbins EPB will be Azerbaijan's first-ever TBM.**



# South Korea's longest tunnel completed

Construction of South Korea's longest tunnel in the city of Busan was completed this week, spanning more than 20 km (12 miles).

The national rail builder unveiled the 20.3-km (12.6-mile) tunnel connecting the Nopo district with Busanjin Station through Geumjeong Mountain.

The tunnel is located more than 300 m (984 ft) below ground and the width and height of the tunnel measures up to 14 m and 12 m (46 and 40 ft), respectively.

This is part of the government's Seoul-Busan Express Railway project, in which the country's high-speed rail, KTX, began operating from Seoul to Busan in 2004.

The second phase of construction is to replace the tracks between Daegu and Busan by 2012. ■

# CALL FOR PAPERS

# NORTH AMERICAN TUNNELING CONFERENCE 2010

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**• Complete contact information for corresponding author •**
**• Project name •**

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- Tunnel Boring Machines
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- Equipment Automation
- Conventional Tunneling
- NATM/SEM & Caverns
- Small Diameter Tunneling
- Shaft Construction
- Emerging Technologies
- Lining Design & Precast Segment Advances
- Fire & Life Safety
- Vulnerability & Security
- Seismic Design
- Updating Design Criteria
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## Robbins EPB surpasses record on New Dehli Metro project

In February 2009, one of two Robbins earth pressure boring (EPB) machines boring India's New Delhi Metro conquered a new feat — the machine achieved a weekly advance rate of 168 rings, or 202 m (663 ft). This is the highest advance rate among any of the 14 tunnel boring machines (TBMs) used on the metro project.

Two 6.52-m- (21.4-ft-) diameter Robbins EPBs were commissioned to bore the BC-16 contract of the New Delhi Metro Extension Project, Phase II. The Continental Engineering Corporation (CEC)/Soma joint venture is excavating the twin tunnels that will join Delhi's Udyog Bhawan and Jor Bagh areas. "Everyone at CEC is very pleased and appreciated the performance of the machines," said Kapil Bhati, general manager-operations of the Robbins India office in New Delhi.

The two machines excavated parallel 2-km (1.2-mile) tunnels, breaking through into an intermediate cut-and-cover station at the 1-km (0.6-mile) mark. The record-setting machine finished its final 1-km (0.6-mile) section on March 5, 2009.

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

Approximately 16 km (10 miles) of TBM drives are involved in Phase II of the project, with about 30 km (19 miles) of underground works in total including cut-and-cover stations. The project is on a tight schedule, which calls for all tunneling to be complete by December 2009, in advance of the 2010 Commonwealth Games. The games will be hosted in New Delhi and are expected to bring 5.5 million visitors to the city. ■

## CHAIRMAN'S COLUMN

Continued from page 4

ute, we published a 2009 UCA Calendar using the excellent photographic skills of our members and the projects in North America. Again, I am indebted to many of you who kindly contributed your photographs in response to a very late call from me. We hope to produce a calendar for 2010, but with earlier solicitation of photographs this time around. We anticipate putting out a call for photographs in early September with a selection for the 12 calendars photos in early October. New UCA lapel pins are also available and will be promoted at our various events and on the UCA Web site. For those of you who have not yet used the OneMine.org search engine, it is a valuable and excellent tool. We have received numerous comments from UCA users who recommend OneMine.org and commend those responsible for making this available to all SME members.

Please join me in congratulating this year's UCA award recipients: Lifetime Achievement winner is George Yoggy. Our Outstanding Individual this year is Galyn "Rip" Rippentropp of Frontier Kemper. Also, help me welcome our new executive committee members: Les Bradshaw, President Bradshaw Construction, and Bob Goodfellow, Vice President with Black and Veatch. Their three-year tenure begins July 1. Tom Peyton will be stepping down as past chair and from his responsibilities on the executive committee. We would not be in the current positive circumstances without his tireless and continuous efforts on our behalf. Tom, you have been a tough act to follow as chair and once again, in July, I follow in your footsteps when I accept the position as past-chair.

One last note, our many accomplishments and UCA's ability to be nimble and proactive is in large part attributable to the support and hard work of Dave Kanagy, Executive Director of SME and many hardworking SME staff. In particular, my heartfelt thanks go to Mary O'Shea, Carol Cudworth, Steve Kral, Tara Davis, Heather Bonic and Heather Gravning for all that you had done to help me and the UCA. It has been an honor to serve as UCA Chair these last two years and I will continue to support the UCA and contribute ideas and effort however possible. My thanks to all of you, members of the UCA, who continue to inspire me each day with your innovations, sheer determination and passion for what we do which is to make the most extraordinary feats of construction, in the most challenging of conditions, seem ordinary and mundane. See you in Las Vegas! Thank you. Brenda. ■

# Mass Transit Tunnel to receive $200 million in funding in 2010

President Barack Obama designated the Access to the Region's Core (ARC) Mass Transit Tunnel (MTT) in New Jersey to receive $200 million in the administration's fiscal year 2010 federal budget. This brings the total federal funding commitment to the MTT project so far to nearly $400 million.

"The President's inclusion of this money for the Mass Transit Tunnel is a clear indication of the administration's strong support for what is the largest transit project getting under way in the nation," New Jersey Gov. Jon S. Corzine said.

The MTT will create 6,000 construction and related jobs a year during the life of the project, and generate 44,000 permanent jobs upon completion. The Tunnel will add $10 billion in gross regional product and $4 billion in additional real personal income.

Construction of the MTT will break a transportation bottleneck at the Hudson River, where the existing 100-year-old commuter rail tunnel under the river has only two tracks that are pushed to their functional limits each rush hour with NJ Transit and Amtrak trains. The MTT will more than double peak capacity between New Jersey and Manhattan from 23 trains per hour to 48.

In addition to two new side-by-side single-track tunnels, the project will create a state-of-the-art expansion to Penn Station New York, with wider platforms and more escalators to ease commuters' trips. The new tracks also will provide direct access to NYC subway lines, PATH trains and existing Penn Station services.

The project will also create one-seat (direct) commutes to New York for NJ Transit customers on seven commuter rail lines as well as future rail expansion lines and more frequent service and more express service on all lines.

Port Authority executive director Christopher Ward noted the MTT will provide vital transportation benefits for the entire region. "By doubling train capacity between New Jersey and New York, we will assure the region remains competitive in the decades ahead."

Governor Corzine has made the MTT a top transit priority. The gov. efforts resulted in the commitment of $5.7 billion in regional funding for the MTT, including $3 billion from the Port Authority of New York and New Jersey and $2.7 billion from the New Jersey Turnpike Authority, state congestion mitigation funds and the state Transportation Trust Fund.

NJ Transit is the nation's largest statewide public transportation system providing more than 895,000 weekday trips on 240 bus routes, three light rail lines and 11 commuter rail lines. It is the third largest transit system in the country with 164 rail stations, 60 light rail stations and more than 18,000 bus stops linking major points in New Jersey, New York and Philadelphia. ■

# First MTT contract approved

The NJ Transit Board of Directors advanced the nation's largest new public transportation project into the construction phase by unanimously approving the first of numerous contract packages for the multi-billion-dollar Mass Transit Tunnel (MTT) initiative.

The board action sets the stage for a MTT groundbreaking ceremony in the coming weeks and greenlights construction of a railroad underpass at Tonnelle Avenue in North Bergen. The underpass will be adjacent to where the $8.7 billion project goes underground, allowing the MTT's two new rail tracks to begin their descent under Palisades Mountain.

The Board's approval of the project's first construction contract follows last week's announcement that President Barack Obama is including $200 million in additional funding for the project in the FY 2010 federal budget, bringing the total federal commitment to date to $378 million.

Of even greater importance was the announcement that the MTT project is being recommended for an Early Systems Work Agreement which formalizes the federal government's long-term funding commitment. ■

RAPID EXCAVATION AND TUNNELING CONFERENCE

# RETC

# More than 1,200 professionals expected at RETC

More than 1,200 professionals from the global tunneling and underground space industries are expected to be on hand for the 2009 Rapid Excavation and Tunneling Conference to be held at Caesars Palace in Las Vegas, NV. The conference, set for June 14-17, is sponsored by the Society for Mining, Metallurgy, & Exploration, Inc. (SME) and the Construction Institute of the American Society of Civil Engineers.

The four-day conference will feature more than 100 technical papers in 19 sessions. Two one-day short courses are also planned, as are a pair of field trips. And the show's exhibit will feature more than 120 of the industry's leading equipment and service suppliers.

## Technical program

**Sunday.** The technical program at RETC begins Sunday afternoon with a single session beginning at 1:30. The six papers in the Risk Management system include Hindsight is 20/20 — reverse engineering tunnel risk assessment; Getting the engineer's estimate right; and Transfer of a project risk register from design into construction, lessons learned from the WCCS Bi-County water tunnel project. Other papers in the session include Delivery of underground construction projects in the U.K.; a review of good practice; Using risk analysis to support decision making in the Central Subway project; and Short tunnel-high risk, pipeline construction involving opencut and tunnel segments.

**Monday.** The morning program will include four concurrent sessions. The Difficult Ground session will include Times Square connection: supporting the cross roads of the world; Gibe II tunnel project — Ethiopia — 40 bars of mud acting on the TBM special design measures implemented to face one of the most difficult events in the history of tunneling; Design and construction of the Lenihan Dam outlet tunnel and shaft; and Daniel Island surprise — sand lens lurking in Cooper marl, Charleston, SC. Other papers include San Vincente pipeline — reach 4W, 3 and 2: case history; and Review of tunneling difficulties in carbonate sedimentary rocks.

Six papers are included in the Las Vegas session. Those papers include Design and construction of the Lake Mead intake No. 3 shafts and tunnels; Project delivery selection for southern Nevada's Lake Mead intake No. 3; Design and subsurface construction at Yucca Mountain, Nevada; and Feasible tunnel construction options for the Systems conveyance and operations program Reach 3 tunnel. Others include What happens in Vegas: the Apex tunnel geologic investigation; and The cost and benefit of the phase 2 investigation for the Reach 4 tunnel, how a roll of the dice came up big in Las Vegas.

The third Monday morning session is New Projects 1. The papers include Planning new metro subways, Los Angeles, California; Slurry TBM tunnel in rock, the modified Detroit River outfall No. 2; and Port of Miami tunnel update — a view from the design builder's engineer. Other papers in this session include Design considerations and evaluation process for a new tunnel and ocean outfall project; and MBTS Silver Line phase II — completes Boston's newest transit line.

The final morning session is TBM Case Histories 1. Papers include TBM tunneling at the Ashlu hydropower project, Squamish, BC; TBM and NATM combined solution for a very deep tunnel, the Pajares case; and 8-m-(26-ft-) diameter, 7-km-(4.3-mile-) long Beles Tailrace tunnel (Ethiopia) bored and lined in basaltic formations in less than 12 months. Other papers include Construction of Louisville Water Company's Riverbank filtration tunnel and pump station project; Technical considerations for TBM tunneling in the Andes; and Robbins 10-m (33-ft) double shield tunnel boring machines on Srisailam Left Bank Canal

Steve Kral,
Editor

tunnel scheme, Alimineti Madhava Reddy project, Andhra Pradesh, India.

Monday afternoon's technical program will also feature four concurrent sessions. The Conventional/Rock Tunneling session will include High-speed excavation by drill-and-blast with mechanized mucking system — Mitholz railway tunnels, Switzerland; Lake Dorothy hydroelectric project, lake tap and tunnel, Juneau, Alaska; and Underground construction for a combined sewer overflow system in Providence, Rhode Island. Other papers include Modern caverns in Gotham — geotechnical and design challenges for large rock caverns in Manhattan; and Tunneling under the Harlem River.

A session on Design/Planning will have six papers. They include Bay tunnel — design challenges; Selection of excavation methods for the Detroit Upper Rouge tunnel CSO control project; Planning and design features of the Waller Creek tunnel, Austin, Texas; and NATM strategies in the U.S. — lessons learned from the initial support design for the Caldecott fourth bore. Other papers include The price is right — planning large water tunnel contracts in New York; and Daylighting Thorn Creek tunnel into Chicago's TARP Thornton composite reservoir.

A session on Shafts is also scheduled for Monday afternoon. Papers in this session include New technology changes in blind shaft drilling; Tamerlane hoist and vertical belt project; Small diameter shaft design alternative; Kansas River tunnel shaft drilling; and Design considerations for the use of slurry walls as permanent walls for deep rectangular shaft structures in seismic areas — Silicon Valley Rapid Transit project.

Monday's final session will be Slurry/EPB 1. The seven papers in this session include Selection, design and procurement of North America's largest mixshield TBM for Portland, Oregon's East Side CSO tunnel; Construction of drilled shafts for the Upper Northwest Interceptor sections 1 and 2 project, Sacramento, California; Port Authority of Alleghany County North Shore connector project tunnels and Station Shell case history Contracts 003 and 006; and Construction of the North Dorchester Bay CSO storage tunnel in Boston. Other papers include High risk tunneling adjacent to large water tank on the UNWI sections 3 and 4 project; Construction works of large-section, vertically parallel twin tunnels in close proximity; and Practical approach for precast concrete segmental ring selection.

**Tuesday.** Papers in the Innovation on Tuesday morning include Uetliberg tunnel: soft ground excavation and premiere of new tunneling machine, world's first tunnel bore extender excavated by undercutting; and Extensible conveyor systems for long tunnels without intermediate access. Other papers include New cutter soil mixing (CSM) technology used to construct microtunneling shafts for Mokelumne River crossing; Introduction to virtual design and construction (VDC); Placement of concrete lining for water tunnel No. 3, Manhattan portion.

The second concurrent session on Tuesday is New Projects II. Papers include Design of NATM tunnels and stations of Silver Line Phase III project in Boston; Geotechnical and structural design challenges of the Fremont Central Park Subway for the BART Warm Springs extension; Atlantic North-South tunnel; and Proposed contracting practices for the Caltran downtown extension.

The New York City session includes five papers. They include Alternative final cavern linings for the East Side Access Transit Project; Continuing the legacy: an update on the construction of the new Second Avenue subway; and No. 7 subway extension crossing under an existing subway station: challenges and integration of underpinning into the design of new tunnels. Other papers include Railroad interface management for MTA East Side Access Project tunnels and structures: and Construction of the MCUA tunnel and force mains under the Raritan River, New Jersey, a case history:

TBM Case Histories II papers include Madiq tunnel, Lebanon TBM tunneling vs. karst geology; On site assembly and hard rock tunneling at the Jinping-II hydropower station power tunnel Project; Double shield TBM in challenging difficult ground conditions – a case study from Zagros long water transfer tunnel, Iran; and Impacts of ground convergence on TBM performance in Ghomroud tunnel. Other papers include TBM data management and quality assurance for the Brightwater conveyance project; and Construction of the East Side Access Manhattan tunnels.

The first of three Tuesday afternoon sessions is Geotechnical. Papers in this session include Geotechnical baseline reports – a review; Ground characterization for CSO tunnels in Washington D.C.; Actual vs. baseline tracking during TBM tunneling in highly variable glacial geology; Assessing ground ahead of TBM tunnel using low-interruption a wireless seismic reflector tracking system; and Ground characterization and feasibility evaluation of tunneling methods for Mather interceptor.

Papers in the Ground Modification session include North 27th Street ISS extension, unique owner/contractor agreement settles major disputes; Brightwater conveyance system: and ground freezing for access shaft excavation through soft ground. Other papers include New approach of ASFINAG for tunnel construction monitoring of the Tauern tunnel project in Austria; Research in soil conditioning for EPB tunneling through difficult soils; and An analysis method for modeling compensation of settlements due to tunnel driving by grouting cement suspensions.

The SEM session includes Case history of the Wachovia-Knight Theater pedestrian Tunnels; Boggo Road busway project, Brisbane, Australia; Loosening and face stability with shallow overburden in the Sitina tunnel, Bratislava, Slovakia; Innovative NATM – design for a

large shallow cavern at Stanford; and ADECO – RS as an alternative to NATM: how it works, why it works.

The Slurry/EPB II session concludes Tuesday's technical programming. Papers include Big Walnut outfall augmentation sewer — part II, TBM case history; EPB tunneling through cohesionless saturated ground under very shallow cover, Perth New MetroRail City project; and Sao Paulo Metro project — control of settlements in variable soil conditions through EPB pressure and biocomponent backfill grout. Other papers include Planning and preparation for tunneling at Brightwater West; Brightwater East — a case history; and Gotthard base tunnel, section Faido, previous experience with the use of the TBM.

**Wednesday.** The concluding day of the RETC has three technical sessions. The morning International session includes The Hallandsås dual mode TBM; Effective planning of underground space — planning and implementation of the first underground water reservoirs in Hong Kong; Hobson and Rosedale tunnels — new technology in Auckland; Feasibility and implementation of shield machine tunnel passing through the operating airport runway; and Experience gained in mechanical and conventional excavations in long alpine tunnels in Switzerland.

The Microtunneling session includes Microtunneling 1.2-mile, 72-in. RCP with crossing of NJ Turnpike and CSX railroads; Longest drive — Portland's CSO microtunnels; Microtunnels vs. EPB risk-based selection; Microtunneling challenges in soft ground of downtown Hartford, CT; and Microtunneling for utilities under Harold railroad interlocking.

The Mining session Wednesday morning includes Technical challenges in mine rehabilitation; Openpit TBM driven drainage tunnel — OK Tedi Mine; Deep underground science and engineering laboratory and the construction of physics megacaverns, and Subsurface repository ventilation design.

The proceedings from the 2009 Rapid Excavation and Tunneling Conference are available from SME, Customer Service, 8307 Shaffer Parkway, Littleton, CO 80127, phone 303-948-4200, fax 303-973-3845, e-mail cs@smenet.org, Web site www.smenet.org.

## Social activities

The Monday Welcoming Luncheon at RETC will feature an expert in the field of underground construction and tunneling. Also at the luncheon, the Underground Construction Association of SME (UCA) will present its awards. The Lifetime Achievement Award will go to George D. Yoggy. The Outstanding Individual Award will go to Galyn "Rip" Rippentrop. And the Project of the Year Award will be the Combined Sewer Overflow Abatement Program Phase 1, Narragansett Bay Commission. See page 38 of this issue of T&UC for biographies and details.

The UCA of SME will also have its annual breakfast on Tuesday morning. There, outgoing UCS Chair Brenda Bohlke will report on UCA activities that took place during the two years she was chairman. And she will install David R. Klug as the new chair of the UCA of SME.

The RETC Dinner is scheduled for Tuesday evening. Entertainment will be provided by The Water Coolers, who will entertain the crowd with a combination of sketch comedy and music about getting through everyday life, including work, kids, husbands, wives, travel, technology and how to balance them all.

Sponsoring companies of RETC include AECON Constructors, American Commercial Inc., Black & Veatch Corp., Brierley Associates LLC, CDM, Crux Subsurface Inc., Hatch Mott MacDonald Co., Herrenknecht Tunneling Systems USA Inc., Kiewit Construction Co., Lovat, McNally Construction Inc and The Robbins Co.

## Short courses and field trips

Two short courses are scheduled for Sunday, June 14. Recent TBM Innovations and Applications is a three-hour course that will cover the latest trends and applications of mechanized tunneling from micro to macro tunneling boring machines. These include slurry, EPB and hard rock. This course is suited to tunneling professionals involved in the design, procurement and contracting aspects of a project.

Structural Monitoring as a Risk Management Strategy in Underground Construction is a four-hour workshop that will help the professional identify the ways in which structural performance monitoring can play a central role in managing risk associated with underground construction. The workshop will also demonstrate how the process is being used on several major infrastructure projects.

RETC attendees can also join one of two fields in the Las Vegas area. The first, on Wednesday, is to the Hoover Dam. Built during the Great Depression between 1931 and 1935, the dam is a National Historic Landmark and has been named one of the Seven Engineering Wonders of the Modern World.

The second field trip is to Southern Nevada Water Authority's Third Water Intake in Lake Mead and the Clean Water Coalition's River Mountains Tunnel No. 3. The Lake Mead Intake No. 3 project will protect municipal water customers from water quality issues and reduced system capacity associated with declining lake levels.

The River Mountains No. 3 tunnel is part of the system conveyance and operations program (SCOP). Included in the project is a 44-km (27-mile-) long gravity flow conveyance system. The SCOP project will allow for flexible management of the highly treated effluent from several wastewater plants in the Las Vegas metropolitan area. ■

# RETC 2009 Floorplan and Exhibitor List

| | | | | | |
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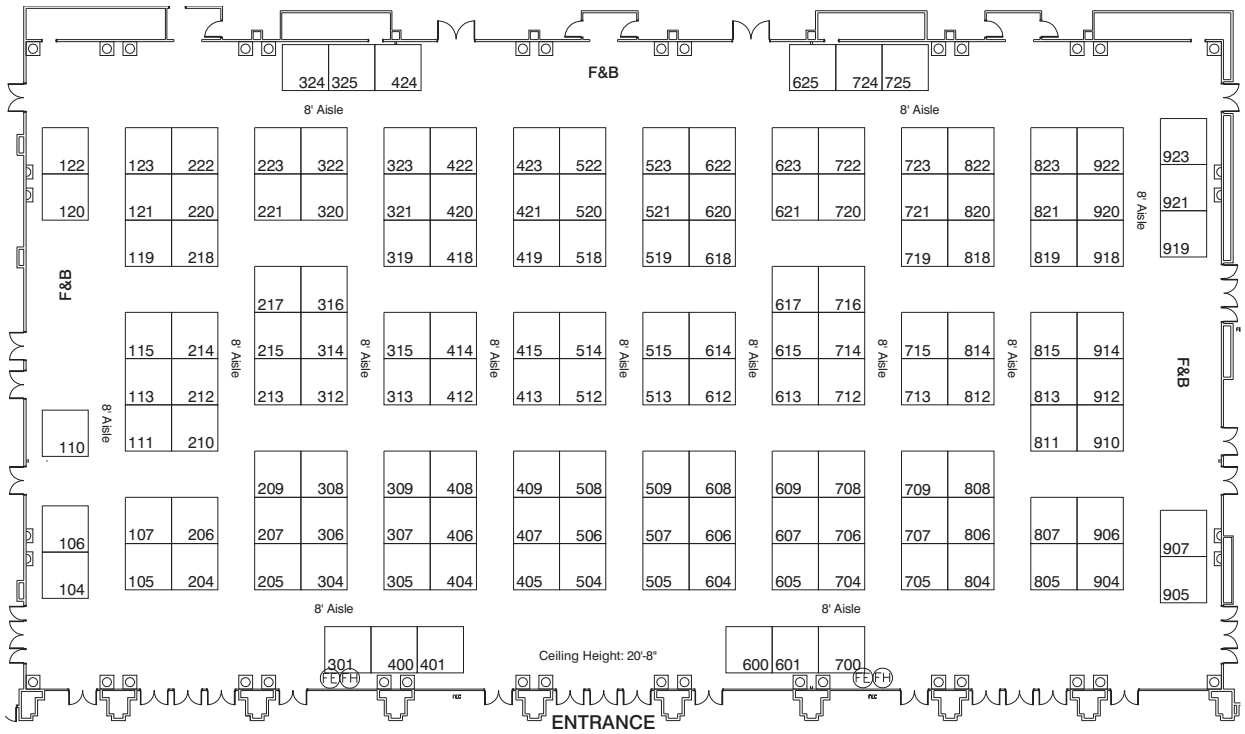


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Robbins
GLOBAL LEADERSHIP. UNCOMMON EXPERIENCE.

# RETC to host more than 120 exhibitors

The Rapid Excavation and Tunneling Conference (RETC) will be held at Caesars Palace in Las Vegas, NV from June 14 to 17. The biannual conference is one of the largest shows for the tunneling and underground construction industry and this year's conference is poised to be the biggest of them all. More than 1,200 attendees are expected to be on hand for the show. In addition to an excellent technical session, RETC will be the site of 123 exhibitors occupying 150 booths. The following is a look at some of them:

Since1973, **Akkerman Inc.** (booth 705) has provided tunnel boring machines (TBM). Akkerman Inc. sells and leases new and used microtunneling, pipejacking, tunneling, guided boring and earth pressure balance equipment. Akkerman not only manufactures quality trenchless equipment, it has built a reputation for superior reliability and responsive service through a team of experienced engineers, field technicians and a large parts department.

**Akkerman jetting and lubrication pump for its guided boring machine (GBM) system.**

At the

RETC show, Akkerman will be on hand to discuss its complete product line, including the Akkerman Jetting and lubrication pump for its guided boring machine (GBM) system. The new jetting and lubrication pump arrangement allows customers to maintain optimum production rates in variable soil conditions in one compact, easily transported unit.

The Akkerman jetting and lubrication pump features independent hydrostatic flow controls for premium user control in a variety of soil conditions during each step in the three-step GBM process.

Customers have their choice of a 3,000-rpm, 30-hp diesel engine or the equivalent ac electric power source. The large 1,230-L (325-gal) tanks provide appropriate production capacity to meet powered cutter head (PCH) and cutter head with integral swivel requirements.

The 2,500 psi high-pressure jetting pump aides the GBM cutting process by lubricating cutter bits and spoils during excavation. An in-line suction filter protects the pump from contaminants in the water.

The 250 psi lubrication pump assists with lubricating the pilot tubes, casing and augers and product pipe by reducing friction and easing the jacking process. An in-tank agitator mixes the lubrication quickly and keeps it consistent throughout the production process.

The Akkerman jetting and lubrication pump is essential for use with the Akkerman PCH and the cutter head with integral swivel upsizing tool.

Safety and productivity go together in successful underground mines. **Atlas Copco** (booth 605) has introduced the Scooptram ST1030 with a radio remote option that allows miners to leave their post behind the wheel and drive the loader while standing in a safe area, increasing safety and keeping sites more productive.

The Scooptram is particularly advantageous in mines using cemented backfill in underhand cut-and-fill mining. The cemented backfill method allows for more complete extraction while keeping workers safe in less than ideal ground conditions.

The ST1030's well designed cab makes work comfortable for an entire shift inside of the rig. But when needed, the remote feature allows an operator to get out of the vehicle and advance the machine into the muck pile, fill the bucket in one pass and back it up in an efficient and safe motion.

**Atlas Copco's scooptram ST1030**


The remote control allows the operator to control the loading of the 5.9-m (6.5-yd) bucket as easily as is done from inside the cab. This ample bucket capacity speeds the loading process of mid range minetrucks.

The goal of a miner is to be productive and to get home at the end of the shift safely, knowing he has done his job well. Atlas Copco's philosophy of providing innovative products, such as the radio remote control option on the Scooptram ST1030, helps accomplish those goals.

At the World of Concrete show in 2008, **Cellular Concrete's** (booth 110) Geofoam SP was named the most innovative product in the concrete making materials category.

Geofoam SP enables the production of pervious cellular lightweight concrete, a permeable, open-cell material that reduces hydraulic pressure and dead load, stabilizes soil, and filters contaminants from the soil.

Cellular Concrete engineers integrated, smart foam liquid concentrate solutions for construction, mining and manufacturing applications, applying research, innovation and technical expertise and support to help specifiers, contractors, mining professionals, and manufacturers expand markets, improve quality and job site safety, and reduce project/environmental costs.

The Cellular Concrete product line includes protein, synthetic and protein/synthetic blend liquid foam concentrate formulations for use in insulated concrete roof deck and floor construction, low slump and lightweight

concrete applications, and mining and geotechnical applications, including pervious cellular lightweight concretes.

The engineered foams are designed to release their unique physical properties only when mixed with the cementitious materials and a chemical reaction occurs. Construction professionals find Cellular Concrete's smart foam liquid concentrates to be the most stable preformed products in the cellular concrete industry, durable cell structures not affected by long pump runs, extended mixing, or most fly ashes or ground granulated blast-furnace slags.

**ChemGrout's 600 colloidal series.**


When it comes to grouting applications, **ChemGrout** (booth 625) is a company that is steeped in tradition. Born in 1963 as grouting contractors providing cement and chemical grouting field services, the company has gained invaluable experience at more than 350 projects, both large and small.

Currently, ChemGrout provides a range of grouting solutions. Each unit is designed for "balance" of grout delivery. Complete grouting units are always designed to allow the user continuous, nonstop grouting capability at published pumping rates for the unit.

ChemGrout manufactures a wide range of standard and custom built grouting equipment to handle a diverse range of materials and capacities from 1 to 45 GPM and pressures from 50 to 2,000 PSI. High-pressure pumps handle pressures to 2,000 PSI and flows to 20 GPM. Systems can be skid or trailer mounted with power options that include air, gasoline, diesel, electric and hydraulic.

**Geokon Inc.,** (booth 513) has developed a line of reliable vibrating wire sensors that have contributed to the growing worldwide acceptance of vibrating wire as the most suitable technology for geotechnical applications.

The newest addition to this line, model 4500AR piezometer, will be on dispaly at RETC. It is designed to be used with readout systems that can read frequency but do not have the capability to "pluck" the VW gage. This sensor has built-in electronics that cause the gage wire to vibrate in a continuous mode at its resonant frequency. The output from the sensor is a 5-V dc square wave at this frequency. A dc input voltage in the range

of 6- 24 V is required to operate the gage. The current consumption is approximately 21 mA at 12 VDC. The gage output is independent of the input voltage.

Multiple sensors powered simultaneously can be read, up to five sensors per second, and dynamic measurements on a single sensor can be made up to 20 Hz. Upon power up, the gage will immediately start to "ring" at the resonant frequency and will continue to do so until the power is removed. Continuous operation will have no effect on the gage life.

From the smallest to the largest most complex projects, all tunnels have their challenges. **Hatch Mott MacDonald** meets those challenges by combining knowledge of the ground with design and construction technologies that are right for the job. Through years of serving clients according to these simple but essential principles, Hatch Mott MacDonald has delivered some of the most challenging tunneling projects undertaken. The company as won awards for innovation and engineering excellence.

Through the company founders' involvement in the development of London's underground road and rail systems more than a century ago, and its work on Toronto's subway system more then 50 years ago, Hatch Mott MacDonald has an established history of tunneling expertise. The company's association with these organizations continues today - a testimonial to the quality of our work. Hatch Mott MacDonald has engineered more than 2,600 km (1,600 miles) of tunnels worldwide including world-class projects such as the Channel Tunnel. Hath Mott MacDonald has also completed projects through out the United States, and Canada.

**Jennmar Corp.,** (booth 400) has introduced the Expanbol rock bolt range that features friction bolts with superior product characteristics to meet the most demanding roof support applications. The high load-bearing capacity combined with excellent elongation properties ensure safer working conditions and faster excavation cycles for low costs.

Water is pumped into the bolt at 30 MPA expanding the steel tube, the water runs out and the bolt is pressed against the rock providing high load friction capacity.

The Expanbol rock bolts effectively tie rock across fractures and fissures with its high loading capacity. The elongation properties allow for substantial rock movements without shearing the bolt.

The Expanbol rock bolts are manufactured according to the ISO 9002 standards. Each batch of material and finished rock bolts are tested for ensured final quality.

Benefits of the Expanbol include immediate full length support for faster excavation cycles and safer working conditions, simple and clean instructions, adjusts to borehole irregularities, excellent elongation properties add to the application flexibility, reliable installation quality, flexible to variations in drill hole diameter, versatile bolting solution for variable ground conditions and no grouting or use of chemicals needed to avoid contamination

Jennmar was incorporated in 1965. Until 1972, the company engaged in various businesses related to the coal mining

industry. In 1972, Jennmar began to change the primary focus of its business to the manufacturing of roof support systems. Jennmar's first step was the purchase of the manufacturing machinery necessary to begin producing steel mine roof bolts in Cresson, PA.

Since its inception in 1972, **Lovat** (Booth 613) has been custom designing and manufacturing tunnel boring machines (TBM) and has completed more than 700 tunneling projects worldwide. Building on the past 36 years of innovation and success, Lovat is proud to announce the recent completion of its 250th TBM.

Accepted by Costain Ltd. in January 2009, the Lovat MP132SE EPB TBM will be used in the construction of Thames Water's West Ham Flood Alleviation Scheme in East London, UK. In 1987, Costain became one of the first contractors to use a Lovat TBM in the UK.

**Theodora, Lovat's 250th tunnel boring machine.**


The Lovat TBM will excavate and erect tunnel lining for a 3,303-m (10,836-ft) tunnel with a maximum grade of 0.5 percent. The TBM will pass under a local primary school, and was christened "Theodora" by one of its pupils. The geology anticipated along the tunnel alignment consists of Tertiary deposits including Woolwich & Reading, Upnor and Harwich Formations. The depth of cover above the tunnel crown level varies from 15 to 17 m (49 to 56 ft). The entire tunnel alignment is below groundwater. Ground water heights above the tunnel invert level vary from 10 to 14 m (33 to 46 ft).

The 3.4-m- (11-ft-) diameter soft ground TBM is equipped with chromium carbide protected Lovat ripper and scraper teeth. The cutterhead drive is hydraulic and consists of 2- x 188-kW, water-cooled electric motors coupled to variable displacement pumps generating maximum torque and speed values of 1,830 kN·m and 4.8 rpm, respectively. To commemorate this milestone, the

TBM was painted in Lovat's original colors.

**Mining Equipment Ltd.** (Booth 920) has been supplying the mining and tunneling industries with quality rebuilt underground equipment for more than 25 years. The business has grown to encompass new Jetair ventilation equipment fans as well as C.S. Card and Moran Engineering rolling stock.

Mining Equipment specializes in rail-mounted equipment with a large inventory of diesel, battery and trolley locomotives in stock. Various models by Plymouth, Clayton, Brookville, Schöma, Goodman, Greensburg and General Electric can be offered. In addition to locomotives, the company also has a large inventory of rolling stock such as muck cars, flat cars and mantrips. Mining Equipment also builds new rolling stock as well as rolling stock components such as wheel /axle sets and couplers.

Jetair Axiflow Fans, offers a full range of underground ventilation fans and accessories.

Mine Hoists International is a fully-owned subsidiary of Mining Equipment. Based in North Bay, Ontario.

**Moretrench Corp.** (Booth 409) originally designed, built and installed the first practical wellpoint dewatering system used in the United States.

Moretrench American Corporation is still recognized as a leader in construction dewatering contracting, although the firm has continuously broadened its expertise in engineering and contracting well beyond temporary ground water removal and hydraulic barriers. The firm has continuously broadened its expertise in engineering and contracting well beyond construction dewatering and permanent hydraulic barriers.

Moretrench American Corporation serves as the parent company to a number of subsidiaries and affiliated companies including Moretrench American, which solves ground water control problems with the design of pumping systems best suited to the overall requirements of the project; Moretrench Services, which facilitates the owner's production and minimizes or eliminates downtime while completing the client's project on schedule; FreezeWall, which conducts artificial ground freezing installations for civil, mining and environmental applications; Moretrench Environmental Services, which completes projects involving the collection, containment, removal and treatment of ground water and soil; Moretrench Geotec, which executes geotechnical contracting services, including minipiles, soil nailing, jet grouting, tie backs, rock protection, and earth retention and underpinning techniques andGround/Water Treatment & Technology, which performs design, installation and operation of ground water and waste water treatment and recovery systems. GWTT also provides equipment and treatment system rentals.

Founded in 1885 and headquartered in New York City, **Parsons Brinkerhoff** (Booth 404) is a leader in the development and operation of infrastructure to meet the needs of communities around the world. The firm provides strategic consulting, planning, engineering, and program and construction management services to both public and private sector clients.

Parsons Brinkeroff is active in multiple market sectors, including transportation, power, buildings/facilities, water/wastewater, environmental, and urban/community development. The firm has the capability to see a project through its entire life cycle, from planning to implementation to operation and maintenance, and has earned a distinguished reputation for its technical and management expertise.

A 4.25 m (13.9 ft) diameter **Robbins** (Booth 221) EPB is boring with tunnel liner never before used in North America. The machine is using concrete segments imbedded with a PVC inner layer to minimize deterioration by corrosive sewer gases.

In December 2008 the machine was launched to bore Phases 1 & 2 of the Upper Northwest Interceptor (UNWI) sewer project, for the Sacramento Regional County Sanitation District (SRCSD). The 6.1-km (3.8-mile) long tunnel, being constructed by the Traylor/Shea joint venture, will increase the capacity of the area's current sewer systems.

The Robbins EPB was designed with a spoke-type cutterhead and wear resistant plates for abrasive ground. Muck is removed using a 500 mm (20 in) diameter shaft-type screw conveyor that empties onto a Robbins belt conveyor system. To tackle curves on the alignment, the machine has been designed using active articulation rather than the passive system. Active articulation allows the front and rear shield to turn independently of the thrust cylinders, eliminating the common problem of ring deformation in curves.

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

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

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

| TUNNEL NAME | OWNER | LOCATION | | TUNNEL USE | LENGTH (FEET) | WIDTH (FEET) | BID YEAR | STATUS |
|---|---|---|---|---|---|---|---|---|
| Hudson River Crossing | NJ Transit Board THE Program | Newark | NJ | Subway | 8,000 x 2 | 24.5 | 2010 | Under design |
| Palisades Tunnel | NJ Transit Board THE Program | Newark | NJ | Subway | 5,400 x 2 | 24.5 | 2011 | Under design |
| Manhattan Tunnel | NJ Transit Board THE Program | New York | NY | Subway | 6,000 x 2 | 24.5 | 2009 | Bid date 09/22/2009 |
| THE 34th St. Cavern & Station | NJ Transit Board THE Program | New York | NY | Subway | 2,200 | 90 x 90 | 2010 | Under design |
| Second Ave. Subway Tunnels | NYC-MTA | New York | NY | Subway | 30,000 | 20 | 2014 | Under design |
| ESA Queens Tunnel | NYC-MTA | New York | NY | Subway | 10,500 | 20 | 2008 | Bids under evaluation |
| Water Tunnel #3 | NYC-DEP | New York | NY | Water | 24,000 | 20 | 2012 | Under design |
| Harbor Siphons Tunnel | NYC-DEP | New York | NY | Water | 10,000 | 10 | 2009 | Advertising in late 2009 |
| Cross Harbor Freight Tunnel | NYC Regional Dev. Authority | New York | NY | Rail | 25,000 | 30 | 2013 | Under design |
| Cross Sound Link Highway Tunnels | Sound Link | Long Island | NY | Highway | 190,000 | 55 | 2014 | Under design |
| Cross Sound Link Service Tunnel | Sound Link | Long Island | NY | Highway | 95,000 | 38 | 2014 | Under design |
| Silver Line Extension | Boston Transit Authority | Boston | MA | Subway | 8,400 | 22 | 2011 | Under design |
| Near Surface Interceptors | Narragansett Bay Commission | Providence | RI | Sewer | 19,500 | 3 to 6 | 2011 | Preliminary design |
| Bi-County Water Tunnel | Washington Sub. San. Commission (WSSC) | Laurel | MD | Water | 28,000 | 10 to 12 | 2009 | Renda JV low bid |
| East-West Subway Extension | Baltimore MTA | Baltimore | MD | Subway | 32,000 | 18 | 2012 | Under design |
| Corvalis to Fox Mill Water Main | Fairfax County Water Authority | Fairfax | VA | Water | 8,600 | 8 | 2009 | Bid date 06/10/2009 |
| WASA CSO Program<br>Blue Plains Tunnel<br>Anacostia River Tunnel<br>Northeast Branch Tunnel<br>Northeast Boundary Tunnel | DC Water and Sewer Authority | Washington | DC | CSO | <br>23,400<br>12,500<br>11,300<br>17,500 | <br>23<br>23<br>15<br>23 | <br>2011<br>2013<br>2018<br>2021 | <br>Under design<br>Under design<br>Under design<br>Under design |
| Market St. Drainage Improvements | City of Charleston | Charleston | SC | Sewer | 3,000 | 10 | 2010 | Under design |
| South River Tunnel | City of Atlanta | Atlanta | GA | Wastewater | 9,000 | 14 | 2008 | Gilbert Southern low bid |
| North/South Tunnel | Georgia DOT | Atlanta | GA | Highway | 77,000 | 41 | 2015 | Under design |
| Snapfinger Interplant CSO Tunnel | Dekalb County | Decatur | GA | CSO | 26,400 | 28 | 2010 | Under design |
| Port of Miami Tunnel | Florida DOT | Miami | FL | Highway | 7,400 | 39 | 2011 | Awaiting Funding |
| Sewer Replacement | Miami Dade | Miami | FL | Sewer | | 5 | 2010 | Under design |

The editor's of *Tunneling & Underground Construction* encourage UCA of SME members to submit projects to the online Tunnel Demand Forecast at www.smenet.org, log in as a member. The items will be posted on the online TDF once they are verified.

| TUNNEL NAME | OWNER | LOCATION | | TUNNEL USE | LENGTH (FEET) | WIDTH (FEET) | BID YEAR | STATUS |
|---|---|---|---|---|---|---|---|---|
| Lockbourne Interceptor System | City of Columbus | Columbus | OH | Sewer | 10,000 | 12 | 2009 | Under design |
| Alum Creek Relief Sewer | City of Columbus | Columbus | OH | Sewer | 74,000 | 10 to 18 | 2014 | Under design |
| OSIS Aug. & Relief Sewer | City of Columbus | Columbus | OH | Sewer | 25,300 | 18 | 2010 | Under design |
| Olentangy Relief Tunnel | City of Columbus | Columbus | OH | Sewer | 58,000 | 14 | 2012 | Under design |
| Upper Rouge River CSO<br>North Segment<br>South Segment | Detroit Water & Sewer Authority | Detroit | MI | CSO Sewer<br>CSO Sewer | 18,500<br>21,200 | 30<br>32 | 2008<br>2008 | Project cancelled; Kenny/ Obayashi low bid |
| DRO-2 Tunnel | Detroit Water and Sewer Department | Detroit | MI | Wastewater | 6,400 | 25 | 2008 | Project cancelled |
| County Grounds Tunnel | Milwaukee MSD | Milwaukee | WI | Flood Management | 2,700 | 17 | 2008 | Shea/Kenny JV low bid |
| Belmont-Southport Plant Connection | City of Indianapolis DPW | Indianapolis | IN | Sewer | 29,000 | 12 | 2010 | Under design |
| Drumanard Tunnel | Kentucky DOT | Louisville | KY | Highway | 2,200 x 2 | 35 | 2010 | Under design |
| Drumanard Tunnel — Pilot Tunnel | Kentucky DOT | Louisville | KY | Highway | 2,200 | 12 x 12 | 2009 | Under design |
| Waller Creek Tunnel | City of Austin | Austin | TX | Highway | 5,300 x 2 | 60 x 35 | 2010 | Under design |
| River Mountain Tunnel #3<br>CWC Reach 3 | Clean Water Coalition<br>Clean Water Coalition | Las Vegas<br>Las Vegas | NV<br>NV | Wastewater<br>Wastewater | 44,000<br>7,500 | 15<br>15 | 2012<br>2012 | Under design<br>Under design |
| Univ. Link Light Rail Ext.<br>Univ. Link Tunnel U220<br>Univ. Link Tunnel U230 | Sound Transit | Seattle | WA | Subway<br>Subway | 22,800<br>3,800 x 2 | 19<br>18 | 2009<br>2009 | Traylor/FKCI low bid; Bid date 08/11/2009 |
| Alaskan Way Highway Tunnel | Washington DOT | Seattle | WA | Highway | 10,500 | 54 | 2011 | Under design |
| Caldecott 4th Bore | CALTRANS | San Francisco | CA | Highway | 5,000 | 50 | 2009 | Bids 08/11/2009 |
| Third Ave. Subway Tunnel | S.F. Muni Metro | San Francisco | CA | Subway | 10,000 | 20 | 2011 | Under design |
| New Crystal Springs Bypass Tunnel<br>Bay Tunnel<br>New Irvington Tunnel<br>Sunnydale Aux. Sewer Tunnel | S.F. Public Utility Commission | San Francisco | CA | Water<br>Water<br>Water<br>Water | 4,200<br>26,200<br>18,200<br>4,000 | 13<br>10<br>10<br>11 | 2008<br>2009<br>2009<br>2010 | Shank/B-B JV low bid; Advertising 3rd Q 2009; Advertising Mid 2010 Under design |
| San Francisco DTX | Transbay Joint Powers Authority | San Francisco | CA | Transit | 6,000 | 35 to 50 | 2012 | Conceptual design |
| LA Metro Wilshire Extension | Los Angeles MTA | Los Angeles | CA | Subway | 24,00 | 18 | 2010 | Under design |
| Southeast Collector Trunk Sewer | York Region | Markham | ON | Sewer | 15 km | 10 | 2009 | Advertise 2009 |
| Spadina Line Ext.<br>Eglinton West Tunnel<br>Yonge Street Ext. | Toronto Transit Commission | Toronto | ON | Subway | 22,000<br>10 km<br>15,000 | 18<br>18<br>18 | 2009<br>2010<br>2011 | Advertise 2009; Under design: Under design |

# Brightwater's Ballinger Way portal presents deep shaft ground freezing challenges

James D. Nickerson, Joseph M. McCann, David K. Mueller and Paul C. Schmall

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The Brightwater water treatment facilities, currently scheduled to be completed in 2010 and begin operating in 2011, will serve the northern part of King County, WA. The facility includes a new treatment plant and extensive conveyance system consisting of more than 21 km (13 miles) of influent and effluent conveyance tunnels and five portals. The majority of the conveyance system tunnels are mined by tunnel boring machines (TBM) and microtunnel boring machines (MTBM). Tunnel and portal construction is divided into three main contracts. The Ballinger Way receiving portal, constructed under the central tunnel contract, is the terminus for the BT-3 leg of the central contract and the BT-4 terminus of the west contract. The shaft has a 7.3-m (24-ft) finished inside diameter (ID) to accommodate removal of the central project TBM and the west contract TBM and extends to a depth of 66 m (216 ft) below grade through a complex and challenging soil profile characterized by multiple ground water tables.

Vinci Grand Projects/Parsons/Frontier-Kemper Constructors (VCFK) was the joint venture team for the Ballinger Way portal. Frontier-Kemper was responsible for the shaft sinking. VCFK evaluated either slurry wall techniques or ground freezing for earth support during excavation of the portal and liner installation. The selection process took into account the vertical depth, cost, past practice, geology, water tables and a 9-m- (30-ft-) thick zone of contaminated soil at the top of the shaft. Ground freezing, which would also act as a hydraulic barrier, was deemed the better option for this project. The contract was awarded to New Jersey-based geotechnical contractor Moretrench.

Typically, frozen walls, by design, key into an underlying cutoff. At the Ballinger Way portal, however, the freeze bottomed out in a substantially thick stratum consisting of predominantly clay, but with some inclusions of permeable soil that indicated significant ground water pressures. To ensure stable conditions at the bottom of the shaft, Moretrench, which also specializes in dewatering, designed and installed a perimeter array of deep wells to temporarily depressurize the permeable soils.

The movement of ground water generated by pressure

**FIG. 1**

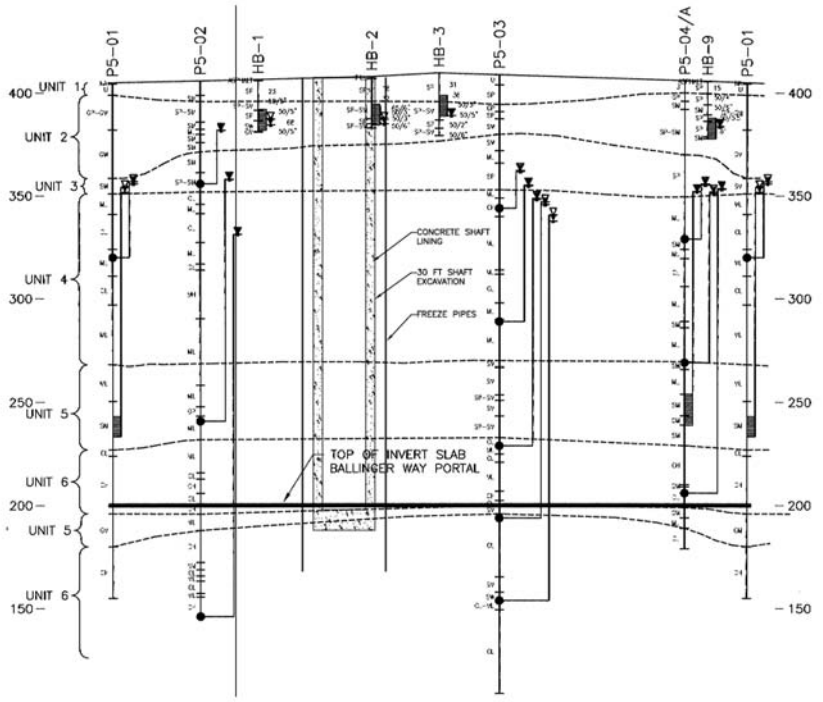
**Soil units (from the Geotechnical Baseline Report ).**

| | | |
|---|---|---|
| **Unit 1** | Vashon Recessional Outwash | Medium dense to dense, moist, slightly silty, sandy gravel and gravelly sand to slightly silty sand. |
| **Unit 2** | Vashom Meltout and Lodgement Till | Very dense, moist, gravelly, slightly silty to silty sand with cobbles. |
| **Unit 3** | Vashon Advance Outwash | Dense to very dense, moist to wet sand and slightly silty to silty sand with occasional layers of sandy silt. |
| **Unit 4** | Glaciolacustrine and non-glacial Lacustrine deposits | Hard, moist to west silt to fine sandy silt, hard, moist clayey silt and hard, moist, low to high plasticity clay. |
| **Unit 5** | Pre-Fraser Glacial Till, Meltou Till and Diamiction | Very dense, moist to wet, gravelly, silty sand, very dense, moist, sandy, silty gravel with cobbles and hard, moist to wet, gravelly sandy silt. Also layers and lenses of gravel, sand, slightly silty sand and silty, gravelly sand. |
| **Unit 6** | Pre-Fraser Glaciolacustrine and Glaciomarine deposits | Hard, moist, low to high plasticity clay with trace to slight amounts of gravel and sand. |

relief can be detrimental to the freeze formation. Therefore, this difficult combination of operations coupled with the depth of freeze — 73 m (240 ft) below grade — made for a particularly challenging project. Added to this, although the portal was off the critical path of the project schedule, work had to be completed before the TBMs arrived and the owner imposed a hefty liquidated damages clause to reflect this requirement. Other owner-imposed restrictions included a 113-L/min (30 gpm) allowable discharge to the existing city sewer system and a workday limited to between 7 am and 10 pm due to permitting requirements that also included noise regulations not to exceed 65 decibels.

**FIG. 2**

**Subsurface conditions (from the Geotechnical Baseline Report).**




## Ground freezing design

Design of a ground freezing system involves structural and thermal design phases. The structural design phase provides the minimum dimensions of the frozen wall. The thermal design phase determines the required freeze time, refrigeration plant capacity, refrigeration plant operation during maintenance freezing and the temperature development and distribution in the soils.

For the Ballinger Way portal, structural analyses were based on a maximum excavated shaft diameter of 10 m (32 ft), an excavation depth of 66 m (216 ft) and a freeze pipe installation depth of 73 m (240 ft). Thermal analyses additionally considered a freeze pipe circle diameter of 14 m (46 ft), a theoretical freeze pipe spacing of 1.04 m (3.44 ft) center to center and 42 freeze pipes.

## Structural design

Based on the geotechnical exploration, representative subsurface conditions had been divided into six soil units. Given the highly complex geologic and ground water conditions, Moretrench developed designs in various soil strata, with particular attention paid to the evaluation of ground water gradients. As well as the subsurface geology, other structural design elements included calculation of stresses and deformations in the circular frozen wall using analytical closed-form solutions.

The final design called for an average freeze wall temperature of -10° C (+14° F) for Soil Units 1 through 5 and -15° C (+5° F) for Soil Unit 6 where lateral pressures were high. The design freeze wall thickness, including a factor of safety, ranged from 1.5 m (5 ft) in Soil Unit 2 to 4.1 m (13.5 ft) in soil Unit 6. Excavation was anticipated to begin after approximately 10 weeks of freezing, at which time a minimum frozen wall thickness of 1.5 m (5 ft) would have developed in Soil Units 1 through 5. Total stand-up time for the frozen face was anticipated to be six months for Soil Units 1 through 5 and three months for Soil Unit 6 since less time was required for bottom-up placement of the final concrete lining.

## Thermal design

Thermal analyses were performed using finite element modeling to determine the time required to form the frozen wall, freeze plant capacity, refrigeration plant operation during maintenance freezing and temperature development and distribution in the soils. Finite element modeling was also used once ground freezing was under way to calibrate the model and confirm design assumptions.

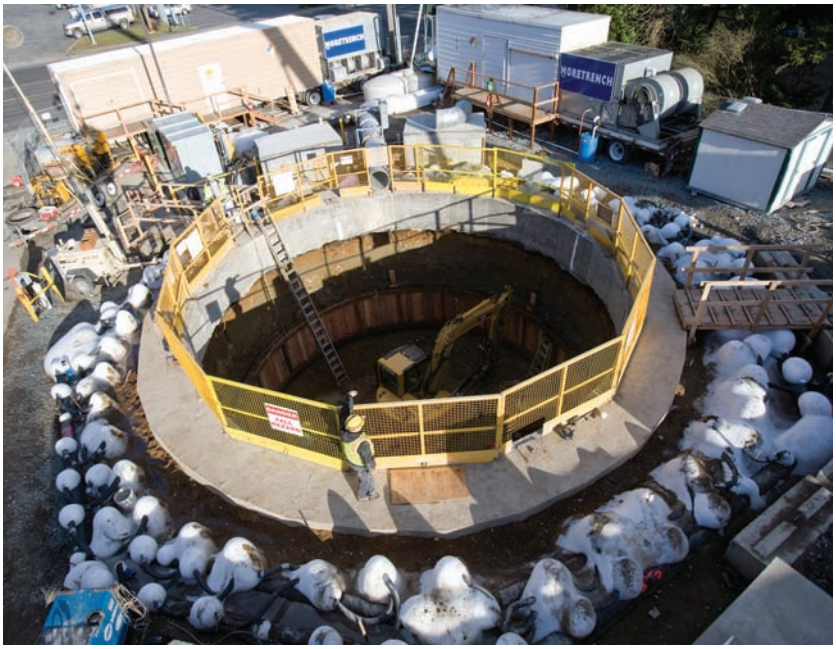
The thermal design analysis resulted in a refrigeration requirement of three plants, each operating at approximately 373 kW (500 hp) for the first 10 weeks, two plants for the next 10 weeks and a single operating plant for the remainder of the ground freezing operations. Closure was anticipated to occur at approximately 10 weeks in Soil Unit 6, assuming a maximum freeze pipe spacing of 2.4 m (8 ft) that accounts for drilling deviations. Full structural formation was shown to occur at approximately 20 weeks in Soil Unit 6.

## Instrumentation and monitoring

Comprehensive quality control is key to ensuring

**FIG. 3**

**Operating ground freezing system.**




that a freeze formation progresses as designed and that, ultimately, full closure and thickness of the cofferdam is achieved. At Ballinger Way, this included a central pressure relief well screened through the water-bearing soils to relieve water pressure buildup within the unfrozen core of the shaft as the freeze continued to grow inward. Data logging probes were installed in the relief well to monitor ground water elevations. Four monitoring pipes, located within and outside of the freeze pipe array, were equipped with thermocouple wire temperature sensors installed at select intervals within each soil unit. Temperature data was recorded by an automated data acquisition system. This custom-built unit consisted of thermocouple scanning modules and a data recorder. The data obtained allowed real-time analysis as the freeze progressed, temperature distribution within the freeze wall and freeze wall thickness.

## System installation and operation

To depressurize the permeable soils in units 5 and 6, Moretrench installed three 152-mm- ( 6-in.-) diameter pressure relief wells to a depth of 67 m (220 ft) below grade around the exterior of the shaft to cater to a calculated total system flow of 189 L/min (50 gpm). The deep wells were installed during the freeze pipe system installation but not activated until freeze closure had been achieved. They remained operational until the portal had been completed.

The 42 freeze pipe locations were spaced at approximately 1 m (3.4 ft) on center in a circular array 14 m (46 ft) in diameter. At each location, a temporary surface casing was installed to a depth of approximately 9 m (30 ft) to prevent vertical migration of surficial contamination during drilling operations. Mud rotary drilling techniques were then used to advance the drill holes to full design depth. Directional surveys of all freeze pipes were made using an inclinometer to measure verticality. From the freeze pipe head assemblies, coolant supply and return hoses were connected to custom-built, insulated manifolds that distributed the chilled calcium chloride brine solution pumped from Moretrench's self-contained, mobile refrigeration plants.

Of the six separately identified soil units at the Ballinger Way portal, Unit 6, the deepest in the series, required the thickest and coldest structural support system. But even if this was in place early, it would not be fully stressed for many weeks after starting shaft excavation from the surface. The freeze design was, therefore, integrated with the shaft sinking schedule.

Soil Unit 6 was the last zone to achieve closure, which was verified after approximately 30 days of continuous operation. This was considerably less than the 10 weeks anticipated from the thermal design modeling since the largest gap between installed pipes was 2 m (6 ft), 0.6 m (2 ft) less than the assumed maximum pipe spacing. The finite element model, incorporating actual data from the field, concluded that full structural thickness was achieved in Soil Unit 6 after approximately 110 days of continuous operation.

## Excavation and liner installation by Frontier-Kemper

Prior to freeze pipe installation, an existing facility had to be removed, the remaining site cleared and

**FIG. 4**

**Hoe ram excavating frozen ground.**

grubbed, environmental controls instituted and site utilities set up.

Drilled holes for the freeze pipes were cased for the top 9 m (30 ft) and grouted to isolate the contaminated zone. The air and in situ soil was continually sampled and tested to ensure there was no risk to employees and the environment. The excavated material was tested by a local environmental contractor and hauled to an approved disposal site. Following the 10 weeks required for the frozen wall to develop, the shaft collar, handrail and survey controls were installed, together with a customized headframe and work deck assembly operated from the surface by means of four Bayard winches.

A 181-t (200-st) crane was used for hoisting a 28.5-bank $m^3$ (10-cu yd)sinking bucket. This was loaded by a 12.7 t (14 st) excavator fitted with multiple quick attachments that included a bucket, a rotary head miller and a hoe ram. The majority of excavation was accomplished by hoe-ramming, with the milling head only used in limited zones of particularly hard or frozen ground. The shaft alignment was monitored by using plumb-bob measurements and tape extensometers to measure convergence. In addition, four inclinometers were installed around the circumference of the shaft to accompany this monitoring.

The joint venture team had elected to install W8 x 31 steel ring sets with 63-mm- (2.5-in.-) thick lagging for the shaft. This provided additional safety protection against potential sloughing of material as well as a mechanism to install a full-length PVC liner incorporated in the design to satisfy the owner's water leakage criteria. It also provided a barrier in the contaminated zone in the upper 9 m (30 ft) reach, an additional insulation barrier for the ground freeze wall and additional ground support in the upper 9 m (30 ft) for crane loading.

Excavation was conducted in two phases. For the first phase, initial excavation advanced to a depth of 4.5 m (15 ft) from ground surface while three 1.5 m (5 ft) vertical sections of steel set units were preassembled on the surface and then installed. Excavation

**FIG. 5**

**Portal cross section and plan.**

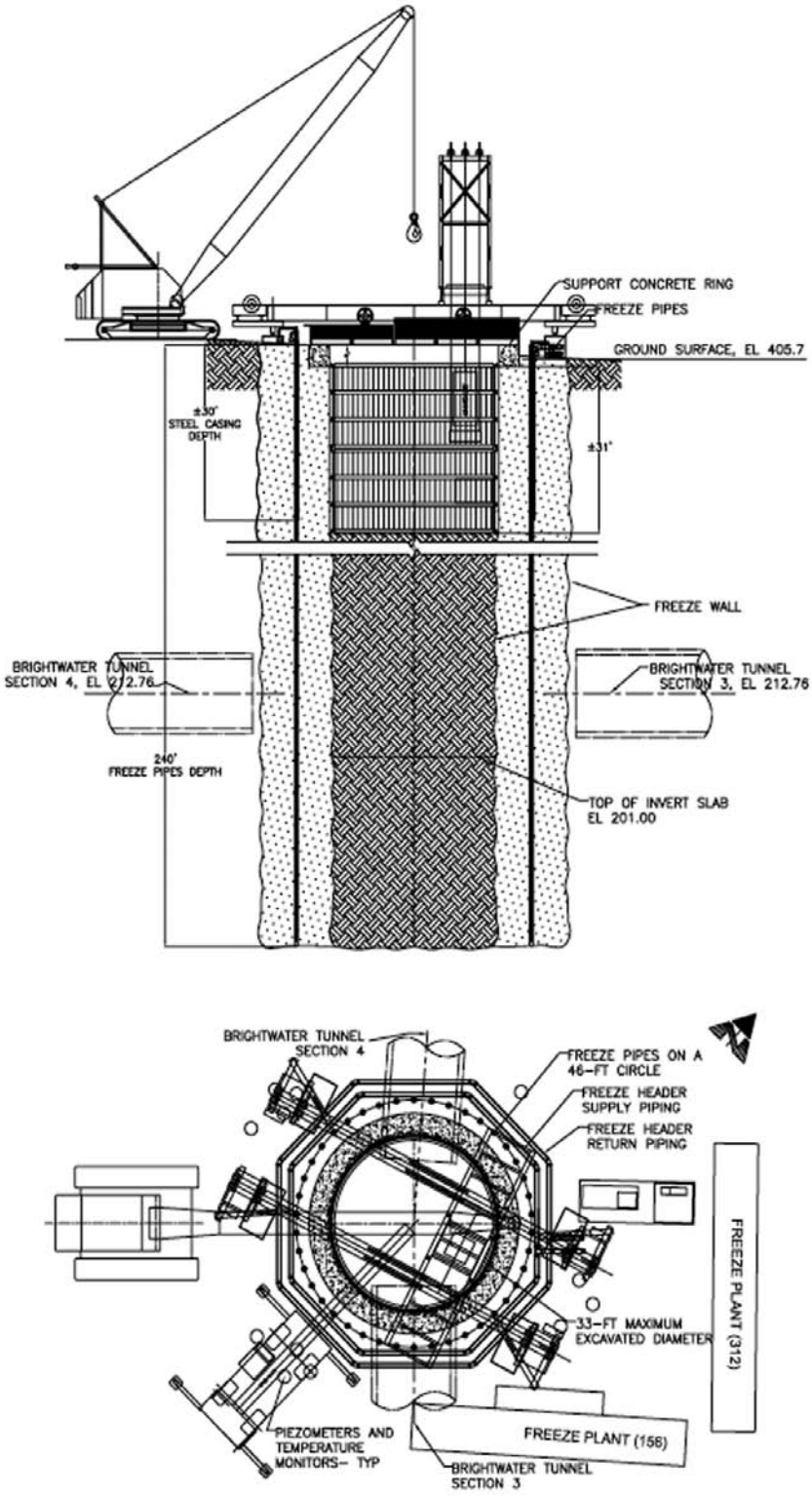


**FIG. 6**

**Deep excavation with sink bucket.**

in 1.5-m (5-ft) increments and steel ring set assembly from inside the shaft continued similarly to 9 m (30 ft). Annulus grout using a bentonite grout mix was poured monolithically for the full 9 m (30 ft) depth to create a barrier between the shaft and contaminated soil.

For the second phase, beneath the contaminated zone, shaft excavation continued in 1.5-m (5-ft) increments, with intermittent stops at 4.5-m (15-ft) intervals to place the annulus grout in conjunction with the shaft excavation. Excavation and grouting continued in this manner until the design depth was reached at 66 m (216 ft) below ground surface.

Once the excavation was complete, a 152-mm (6-in.) non-structural work slab was poured. The steel sets support was then removed from the bottom of the shaft to facilitate reinforcement at the locations of the two tunnel tie-ins. The PVC liner was then installed from the top down using a work deck assembly. With the liner in place, the reinforced invert was poured and work progressed with the shaft liner at the tunnel tie-ins. This section was necessarily more robust than usual, requiring additional rebar reinforcement due to the loading of the tunnel interfaces.

Once the concrete lifts for the tunnel eyes portion were completed, a 3-m (10-ft) compression shaft form was lowered and 18 sequential lifts were poured until completion. Pouring concrete at depth in a frozen shaft is a challenge due to the hydration of the concrete reacting to the cold temperatures and the resulting condensed vapors. Additional ventilation was installed to overcome reduced visibility and facilitate completion of the shaft lining.

**FIG. 7**

**Installed PVC liner.**

The freeze was maintained for the entire duration of the excavation and turned off just before the conclusion of concrete liner installation. The maximum excavation and concrete deviation from design alignment throughout the shaft length was 25 mm (1 in.).

Close cooperation between the joint venture partners, Moretrench and the owner was the key to the success of the project. "The Ballinger Way shaft was considered to be a technically demanding challenge: a deep shaft to be constructed in changing ground conditions with high hydrostatic head and contaminated soil in the upper reaches, undertaken within the confines of a constrained site," said Derek Dugan of CH2M Hill, resident engineer for King County. "The joint venture drew on upon their extensive expertise in shaft sinking to successfully achieve the required result. Their innovative and professional approach to all phases of the construction was impressive and resulted in a quality product, achieved without a single safety or environmental incident." ■

FEATURE ARTICLE

# Cost effective tunnel development in Slovakia

In the drive for faster development advance rates, railbound systems can be advantageous, in the right application. Skanska BS, the contractor to mine-owner VSK Mining, is driving an adit access deep into the Volouské Urchy Mountain in Slovakia to access the Gemerská Poloma talc deposit, some 70 km (43 miles) west of Košice, the economic and cultural center of eastern Slovakia.

Skanska began driving the Stolna Elisabeth drift in February 2007, extending 25 kg/m (50 lb/yd) rails (with 750 mm or 30 in. between sleepers) into the mountain to provide the main haulage to bring talc ore and waste out of the new mine once it gets into production. It will also be used for personnel transport, and is now almost complete. As a second egress and for ventilation, a 2.5-m- (8.2-ft-) diameter shaft of about 300-m (984-ft) depth will be sunk from surface down into the orebody.

**The Häggloader 9HR-B loader. The 'B' signifies a backhoe as the unit is equipped with an 85-litre capacity backhoe bucket rather than the loading arms that are more normal equipment for Häggloaders. This was chosen for its flexibility and ability to dig a mine water drainage ditch alongside the rail in addition to its loading duties at the face.**

Stolna Elisabeth is a 4.2-km- (2.6-mile-) long drift mined at a cross section of some 11 $m^2$ (118 sq ft). The finished profile is 3.2-m- (10.5-ft-) wide by 3.6-m- (11.8-ft-) high. It has been developed on a very slight incline so that water runs down it to the portal. The portal is 450 m (1,476 ft) above sea level and the end of the tunnel is 475 m (1,558 ft) above sea level.

Much of the rock through which it has been developed is magnesite with a compressive strength of 150 MPA. The drilling jumbo is an Atlas Copco twin-boom Boomer 282 Raildrill drilling 42- to 45-mm- (1.6- to 1.7-in.-)diameter holes to a maximum length of 2.5 m (8.2 ft), depending on ground conditions. This is a drill jumbo that Skanska has used successfully on a number of projects during its life.

The condition of the rock through which this drift has been driven is extremely variable. Five classifications of A1 and A2 and B1, B2 and B3, where A1 is the most competent rock and B3 is the worst, have been established. The amount of support used, of which more later is determined by the classification of ground conditions.

At the time of the author's visit, the project it was about 40 days ahead of schedule, thanks to high advance rates. For instance 6 m/day (20 ft/d) was the plan for the advance to be achieved in B1 rock, but sometimes the crews have achieved 8 m/day (26 ft/d) – which is the average for the whole project – in those conditions. In A1 the best advance rate achieved is 12 m/day (39 ft/d).

The loading unit is a Häggloader 9HR-B on crawler tracks with a pony track to run on the rails. This allows the unit to be towed up and down the drift along the rails. To load from the face, the Häggloader lowers the foot of its onboard conveyor system to the floor and the backhoe pushes material on to it. This digging arm-conveyor combination produces uninterrupted, optimal volume loading of the haulage unit, without spill – a technique offering load capacities as high as 180 $m^3/h$ (6,356 cu ft/hour). Furthermore, as an electrically powered machine, it offers great

John Chadwick

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**The Shuttletrain enters the tunnel.**


savings in the energy needed for ventilation.

Skanska chose a crawler-mounted Häggloader with an eye to the future contract, not yet awarded, to drive the ramp system from Stolna Elisabeth into the orebody, where cut and fill will be the mining method.

## Shuttletrain haulage

The Häggloader loads a train of three or four (depending on the volume of rock blasted from the face) 11.5 $m^3$ (406 cu ft) capacity (22 t or 24 st) HRST115 GIA shuttlecars. These are specifically designed to work with GIA's Häggloaders and allow truly continuous loading. Muck is loaded directly onto the shuttlecar by the Häggloader and then transferred from car to car by the built-in conveyors, along the length of the Shuttletrain, which is drawn by a 20- t (22-st) GIA locomotive. The project also has a 15-t (16.5-st) GIA locomotive for shunting other equipment.

The bottom of each shuttlecar body comprises a chain conveyor that facilitates the transfer of rock from one car to the next. The discharge end of each car is adapted to fit the loading end of the car behind. Thus, the chain conveyors form a single train-long unit. With a capacity of 11.5 $m^3$ (406 cu ft) in each car, this project's maximum train of four cars can provide a total haulage capacity of 46 $m^3$ (1,624 cu ft).

The use of shuttlecars eliminates the need for double tracks or switch control stations. Nor is it necessary to blast extra niches for bypass point or switches. This offers considerable savings, especially if such spaces must later be filled in again with concrete. Using the shuttlecar means that the drifts need be mined no larger than required for the ultimate purpose. In fact, this project does have four switch bay sections, 6-m- (20-ft-) wide equipped with double track. The first is 300 m (984 ft) in from the portal, then one at 1.5 km (1 mile), another at 2.5 km (1.5 mile) and the last at 3.5 km (2.2 mile). These are 50- to 75-m- (164- to 246-ft-) long with a 1.2-m (4-ft) gap between the twin lines.

On average, the Skanska teams have achieved four cycles of drill-blast-muck-haul-shotcrete and track laying each day. The drift has been lined by the dry shotcrete method, supplied from an Aliva unit. No support is needed in A1 rock and the support provided elsewhere varies from shotcrete alone to a comprehensive support system in B3 rock. Here, steel arches are set and a layer of steel mesh is placed between the arches, which is then shotcreted. Another layer of mesh is placed on top of that and it, in turn, is shotcreted.

The GIA machines were supplied new by the regional distributor ISOP. That company provides a technician who visits the project regularly and undertakes all maintenance except the daily checks, which the development crews undertake.

One of the reasons the Häggloader with shuttlecar system was chosen was because VSK-Mining's project consultant, Werner Steck, was previously the project manager of the Plabutsch tunnel project in Austria, where he successfully used this system. At one stage during that project, he was congratulated by a telex from the project owner for the very rapid advance in the tunnel. The telex stated that the project advanced 621 m (2,000 ft) in 26 working days. As a result of this good experience with the system, Steck advised VSK-Mining to use the system.

## Cut-and-fill mine

The talc orebody and dolomite body is underlain by granite and overlain by dark green sericite phyllite that outcrops on the surface. The talc occurs in lenses, veins and layers that are distributed irregularly within the dolomite. The talc is mainly light green to gray in color (chlorite) and massive. The main impurities are pyrite, chlorite, dolomite, magnesite and quartz where the latter three occur in the form of "floating" blocks within the talc. Pyrite and chlorite are dispersed throughout the talc.

Various preliminary reserve and resource calculations have been made, with figures ranging from 25 Mt (27.5 million st) going up to 160 Mt (176 million st). Only the reserve of the core of the deposit is proven at this stage, at 1.6 Mt (1.76 million st), but it is a very large talc deposit. Better knowledge of its real size and quality will be provided by horizontal drilling once the deposit has been accessed from the ramp. The orebody intersected by surface drill holes was found to have an east-west dimension of 2,700 m (8,860 st) and a north-south dimension of at least 820 m (2,700 ft). The orebody lies on average some 350 m (1,150 ft) below surface. The so-called west zone has dimensions of 850 m (2,800 ft) in the east-west direction and some 820 m (2,800 ft) north-south. The thickness of the mineralized zones varies between 2 and 375 m (0.6 and 1,230 ft). The plan at this stage is for a 600-t/d (661-stpd) operation. ■

# Chunnel repairs call on Conjet hydrodemolition robots

Train services through the Channel Tunnel linking Britain and France where scheduled to be fully restored in February 2009 following several months of repairs after a major fire in the tunnel on Sept. 11, 2008. A lorry caught fire on a shuttle train carrying heavy goods vehicles bound for France through the 50-km- (31-mile-) long northern tunnel. The fire, that spread to other vehicles, raged for about 16 hours. The extreme temperatures of up to 1,000º C (1,832° F) caused extensive damage to about 600 m (2,000 ft) of the 7.6-m- (25-ft-) diameter tunnel's concrete lining, approximately 11 km (7 miles) in from the French entrance.

**The total area of removal of the fire damaged concrete with the Conjet hydrodemolition robots was about 9,500 m² (102,000 sq ft) over an approximate 600 m (2,000 ft) length of tunnel, including about 350m² (3,770 sq ft) directly above the fire where the damage was most severe.**

The Channel Tunnel operator, Eurotunnel, awarded the repair contract, estimated to be between €50 to 60 million, to a consortium of Freyssinet, Eurovia Travaux Ferroviaires (ETF) and Vinci Energies. Freyssinet was appointed to look after the civil engineering works, while ETF would be responsible for track and overhead wire restoration and Vinci Energies responsible for other equipment. The technique of hydrodemolition, which uses high-pressure water jets to remove concrete from various structures, was specified as the method to remove the fire damaged concrete. Freyssinet subcontracted the concrete removal to the specialist hydrodemolition and industrial cleaning contractor Philip Lasserat.

For the hydrodemolition part of the repair Philippe Lassarat hired four Conjet hydrodemolition robots and pumps, together with a team of experienced operators and a project manager, from Rotterdam-based Doornbos Equipment, a specialist in the rental of ultra high-pressure water jetting and vacuum equipment. To meet the tight schedule, Doornbos had to work three shifts round the clock and opted to use two Conjet 364s and two Conjet 322s. Conjet supplied specially modified banana shaped feedbeams, which carry the jetting nozzle, to match the curvature of the tunnel wall.

"We had to remove the damaged C45 concrete just from the walls and roof to a depth of 30 mm (1.2 in.) and managed this at an average of 650 m²/day (7,000 sq ft/day)," said Doornbos project manager Uwe Clausen. "The total area was about 9,500 m² (102,000 sq ft) over an approximate 600 m (2,000 ft) length of tunnel, including about 350 m² (3,770 sq ft) directly above the fire where the damage was most severe. We removed all of the fire damaged concrete in 14 working days using four Robots. We had to work nonstop, round the clock in three 10-hour shifts, which included an hour in and an hour out at shift change to get through all the security." The robots were supported by 350- and 400-kW (469 and 536 hp) pumps operating at pressures up to 1,000 bar and flow of up to 240 L/min (910 gpm).

After the removal of the damaged concrete, Philippe Lassarat followed on repairing and replacing any fire damaged reinforcing prior to spraying on the new concrete lining. The various services and utilities were then replaced before handing the tunnel back to Eurotunnel to restart a full service of the shuttle trains on Feb. 10. Eurostar, the company that operates the passenger trains running through the tunnel, anticipated services would be fully restored on Feb. 23. ■

PROJECT OF THE YEAR AWARD

# Providence CSO abatement project wins UCA Project of the Year Award

The Narragansett Bay Commission's Combined Sewer Overflow (CSO) Abatement Project in Providence, RI has received the 2009 Project of the Year Award from the Underground Construction Association of SME (UCA of SME). The award was given for the commission's leadership, foresight and motivation in propelling the project from planning to completion. The UCA of SME gives the award to an individual or organization that has shown insight and understanding of underground construction on a significant project. The award will be presented at the welcoming luncheon during the Rapid Excavation and Tunneling Conference in Las Vegas, NV in June. The Jacobs Associates/ Gilbane Building Co. Joint Venture played a key role as construction manager on the Phase I portion of the project.

The Providence CSO Abatement Project is the largest civil works project in the history of Rhode Island. Phase I, which was constructed from 2001 to 2008, was completed at a cost of $350 million. The project dramatically reduces the discharge of sewer and rainwater overflow that enters the bay and its tributaries untreated. Up to 64 million gallons of combined sewage will be collected and transferred to a deep storage tunnel for pumping and treatment.

**The Fields Point tunnel pump station was constructed within a large rock cavern 106 m (350 ft) underground.**

The centerpiece of the project, and the main focus of Phase I, is the 9-m (30-ft) excavated diameter Main Spine Tunnel, 5-km (3-mile) long and about 76 m (250 ft) underground. Tunnel excavation proceeded through sedimentary rock formations using a hard rock tunnel boring machine (TBM). Initial support measures for the Main Spine Tunnel consisted of around 16,000 concrete segments, each weighing 5.4 t (6 st).

Phase I also involved the building of a 4-ML/sec (64-million-g/d) pump station within a sequentially excavated cavern, as well as gate and screening structures, diversion/ relief structures and conveyance conduits. A combination of drill-and-blast, microtunneling, and pipe-jacking methods produced about 2,440 m (8,000 ft) of tunneled adits, connecting to the deaeration chambers, drop shafts, and consolidation pipelines, and collecting the combined sewerage from existing CSOs. Other underground construction technologies also were employed, including TBM mining, raise boring, down drilling, ground freezing, jet grouting, secant piling, sheet piling and dewatering.

## Construction challenges

Challenges to the project were apparent before the first shovel broke ground. With up to 52 m (170 ft) of soil depth at the project site, 10 shafts had to be sunk to rock where overburden support was a major challenge. In many places, the soil was coarse, clean and capable of producing heavy water inflows into excavations. Bedrock included formations of weak graphitic shale with soil-like properties and short standup time, which increased the difficulty of constructing the large-span rock cavern and the 9-m-(30-ft-) diameter bored tunnel. Soil contamination issues were present at many of the sites. Much of the new construction was near historic structures in the heart of downtown Providence, along the waterfront with buried wharves and obstructions, or near live or abandoned utilities. ■

PERSONAL NEWS

Moretrench has promoted **KENNETH R. CHADWICK**, P.E., to the position of vice president. He will continue to serve as chief engineer for the company's geotechnical division and focus on the design and construction of ground treatment, ground reinforcement, specialty foundation systems and underpinning and excavation support.

CHADWICK

MUELLER

Moretrench has also promoted **DAVID K. MUELLER** to vice president. In 2000, Mueller was appointed chief estimator for proj-

(Continued on page 40)

INDIVIDUAL AWARDS

# UCA honors two outstanding members

## Outstanding Individual Award to Galyn Rippentrop

Galyn "Rip" Rippentrop has received the UCA Outstanding Individual Award. Rippentrop is the retired president and chief executive officer of Frontier Kemper Constructors.

RIPPENTROP

Rippentrop has more than 35 years of domestic and international experience in heavy construction, consisting of tunnels and shafts associated with major transportation, water and energy and mine development projects. Some of those major projects were the Rio Piedras project in San Juan, PR; the Congress Heights and New Hampshire Avenue tunnels in Washington, DC; 8 km (13 miles) of twin-bore rail tunnels under the Storebelt Straits in Denmark; the Bad Creek hydroelectric project for Duke Power near Salem, SC and shafts, level development and loadout facilities at the C-b oil shale site in Colorado.

Rippentrop also has eight years of executive management experience presiding over an ENR Top 400 heavy civil contractor. He successfully led the expansion and diversification of services and products offered by FrontierKemper and its subsidiaries.

Rippentrop earned a B.S. in civil engineering in 1974 from the South Dakota School of Mines and Technology. He is a member of the Beavers, the Moles and SME.

## Lifetime Achievement Award to George Yoggy

The UCA Lifetime Achievement Award is presented to George Yoggy. Yoggy has been involved in shotcrete and concrete applications for underground and heavy construction and repair of concrete structures for more than 50 years. He has international experience in shotcrete for ground-support technology employing the New Austrian Tunneling Method and similar techniques developed in Switzerland and Austria, as well as shotcrete for repair and refractory applications.

YOGGY

His career started as a college job with a concrete contractor while attending Wheaton College and the University of Chicago. From 1967 to 1986, Yoggy was a partner in Concrete Equipment Corp. and Shotcrete Plus, a business engaged in the design, manufacture and supply of shotcreting equipment and services for ground support and mass concrete placement. In 1986, the companies became part of Master Builders Technologies. There, he founded the Underground Construction Group for MBT Americas.

Yoggy retired from Master Builders in 2000 and is a consultant to the tunnel, mining and shotcrete industries, specializing in ground support. He serves on technical committees including ACI and ASTM shotcrete, underground and certifica-

**Yoggy** (Continued on page 40)

**Tor Brekke was the recipient of the UCA's 2008 Outstanding Educator Award but was unable to attend the North American Tunneling Conference in San Francisco, CA to receive the award plaque. The plaque was presented to Brekke at his home on June 12, 2008 by his former students and colleagues. Those present included (back row l-r) Ian Brown, Harvey Parker, Gregg Korbin and Dan Zerga; (front row l-r) Matt Fowler, Brenda Bohlke, Tor Brekke and Mike McRae.**

## PERSONAL NEWS

(Continued from page 38)

ects involving ground freezing, construction dewatering, ground water remediation, slurry trench barriers and mechanical installations. He will continue to serve in that capacity.

**PAUL DALIDA** has joined Arcadis as vice president in the Infrastructure Division, assigned to the New York City office. He will play a crucial role in the East Side Access Project as the director of Manhattan projects. Dalida has more than 30 years of experience in road, transit and commercial design, construction and project management. Before coming to Arcadis, Dalida served as senior project manager with Hatch Mott MacDonald. There, he oversaw the construction of a $1.1-billion tunnel and road project, the Florida Department of Transportation Port of Miami Access Tunnel connecting Interstate I-95 to the existing Port of Miami surface roadway system.

**JOHN F. DONOHOE** is a 2009

DONOHOE

recipient of the American Society of Civil Engineers' Opal Award. The award recognizes innovation and excellence in civil engineering projects and the contributions that Donohoe has made to the civil engineering industry during the past 45 years. He joined Moretrench American Corp. in 1964 and ultimately held the positions of president and chief executive officer. He has served as chairman since 1995. He has been president of the ASCE Construction Institute, president of AGC of New Jersey, national director of AGC of America, president of the Moles and president and trustee of CIAP of New Jersey.

Moretrench has acquired the assets of Orlando-based geotechnical contractor John N. Puder, Inc. Under the day-to-day management of **JOHN PUDER**, and doing business as John N. Puder, a division of Moretrench, the Orlando regional office will offer a full range of geotechnical design and construction services throughout Florida and Georgia.

**GLENN BOYCE** was named the 2009 Trenchless Person of the Year by the North American Society for Trenchless Technology (NASTT). The award honors an individual who has made a profound and lasting impression on the trenchless industry. Boyce is a senior associate and supervising tunnel and geotechnical engineer with Jacobs Associates. He has worked in the trenchless industry for more than 25 years and has been instrumental in developing standards for the field of microtunneling. He launched the China Hong Kong Society for Trenchless Technology. Boyce joined NASTT in 1993 and has served as its secretary, vice chair and chair. ■

## ASCE AWARD

# Claremont Tunnel design team wins ASCE award

The East Bay Municipal Utility District's Claremont Tunnel Seismic Upgrade Project received the 2009 Charles Pankow Award for Innovation from the American Society of Civil Engineers (ASCE). The Claremont Tunnel Project was recognized for the novel design features used to upgrade the major water supply tunnel. The award was presented at ASCE's Outstanding Projects and Leaders Gala in April 2009.

The innovative design of the tunnel was the first of its kind. An expanded vault section across the Hayward fault was designed to accommodate up to 2.6 m (8.5 ft) of lateral offset without interruption of water flows. The tunnel lining reinforcement for the vault was designed to curve like a spine in an earthquake, while two side drifts — smaller tunnels on both sides of the bypass tunnel — were completely backfilled with concrete to prevent water from eroding surrounding ground when the lining is offset after a major earthquake.

Jacobs Associates was responsible for the overall design and construction management support. Construction was completed in the spring of 2007. ■

## UCA AWARDS

**Yoggy** (Continued from page 39)

tion. He is a founding member and past director of the American Shotcrete Association, Laborers-AGC Tunnel Advisory Board and is a past president of the American Underground Construction Association.

Some of the projects Yoggy has worked on include the foundation for the World Trade Center, La Guardia Airport runway extensions, the foundations for the Delaware Memorial Bridge, the Newburgh Beacon Bridge and the Maryland Bay Bridge, the New York subway, the Nevada Test Site the Arlberg Tunnel in Austria and, most recently, the St. George Tunnel, the Bergen Tunnel, Yucca Mountain project and World Trade Center repairs. ■

## September 2009

• **09-11, IBTTA 77th Annual Meeting,** Chicago, IL. Contact: The International Bridge, Tunnel and Turnpike Association, phone 202-659-4620, Web site www.ibtta.org.

**13-16, Euro:Tun 2009,** Ruhr University, Bochum, Germany. Contact: Institute for Structural Mechanics - Ruhr-University Bochum, phone 49-234-32-29069, fax 49-234-32-14149, e-mail felix.nagel@rub.de, Web site www. eurotun.rub.de.

• **16-18, Tunnel Construction and Underground Structures,** Ljubljana, Slovenia.Contact: Slovenian Society for Underground Structures, phone 386-1470-4617, e-mail jakob.likar@ntf.uni.si, Web site www.drustvo-dpgk.si.

**23-25, Tunneling Short Course,** Colorado School of Mines. Contact: Office of Special Programs and Continuing Education, Colorado School of Mines, Golden, CO 80401, phone: 303-273-3321, fax 303-273-3314, e-mail space@mines.edu, Web site www. mines.edu.

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

## October 2009

• **08-09, 58th Geomechanics Colloquy 2009.** Salzburg Congress Center, Salzburg, Austria. Contact:OeGG, e-mail salzburg@oegg.at, Web site www.oegg.at/events/geomechanics-colloquy.

## December 2009

• **01-03, STUVA TAGUNG '09,** Hamburg, Germany. Contact: STUVA, e-mail info@stuva.de, Web site www.stuva.de.

## March 2010

• **17-19, The International Symposium on Tunnel Safety and Security (ISTSS) 2010,** Frankfurt, Germany. Contact: Andres Lonnermark, SP Technical Research Institute of Sweden, phone 46-10-516-56-91, e-mail andres.lonnermark@sp.se, Web site www.sp.se/en/units/fire/news/ISTSS2010.

## June 2010

**12-19, North American Tunneling Conference,** Portland, OR. Contact: Meetings Dept., SME, 8307 Shaffer Parkway, Littleton, CO 80127, phone 800-763-3132 or 303-948-4200, fax 303-979-3461, e-mail sme@smenet.org, Web site www.smenet.org. ■

# UCA of SME

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## January 26, 2010
### Graduate Center, City University of New York
### New York, NY

FOR ADDITIONAL INFORMATION CONTACT: Meetings Dept., SME 800-763-3132, 303-948-4200 fax 303-979-4361, e-mail sme@smenet.org

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Year of Election: _____
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## Membership Category* (check one):

☐ **Individual Professional Member**
*Please complete pages 1 and 2*

☐ **Corporate/Sustaining Member**
*Please complete pages 1, 2 and 3*

☐ **Student Member**
*Please complete pages 1 and 2*

## Membership Dues:

| | |
|---|---|
| **Individual Professional Member:** | **$135 per year (+)** |
| *or* (+) Entrance Fee: | $20 |
| (+) Reinstatement Fee: | $10 |
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Phone: _____

Preferred Mailing Address: ☐ Home ☐ Business/School

## Membership Qualifications

### UCA INDIVIDUAL PROFESSIONAL MEMBER

A person eligible for election or transfer into the class of Individual Professional Member shall be either: (i) employed in a position of responsibility in an area relevant to minerals exploration, extraction, production, processing, economics or metallurgy, including employment as an educator, engineer, scientist (including chemistry or any related earth science) management (including but not limited to chief executive officer, financial, legal, or human resources personnel); or (ii) hold a baccalaureate degree, masters degree or doctorate degree in engineering, mineral economics or any related earth, chemical or environmental sciences; or (iii) employed or educated in mineral exploration, extraction, production, processing, economics or metallurgy; or (iv) actively involved, directly or indirectly, with mineral exploration, extraction, production, processing, economics or metallurgy, whether through engineering, scientific, related earth science, management, executive, financial, legal, or human resources experience; or (v) engaged in marketing or technical sales of equipment and supplies used in mineral activities.

**If at any time your record of experience and/or education is questioned for qualification of member grade, you may be requested to provide an endorsement for membership by an SME member in good standing.**

### UCA STUDENT MEMBER

A person eligible for election into the class of Student Member must be a full-time college undergraduate or graduate student in good standing. A Professional Member who subsequently returns to school for an additional degree cannot become a Student Member. All Student Members must be nominated by an existing Member.

### UCA CORPORATE/SUSTAINING MEMBER

UCA of SME Corporate and Sustaining Memberships are designed especially for companies seeking opportunities to promote their organizations, its services and employees. Any industrial organization in the underground construction industry may become an UCA of SME Corporate or Sustaining Member.

#### CORPORATE MEMBER BENEFITS — $750

- Two (2) complimentary Professional Memberships
- Complimentary subscription to *Mining Engineering* magazine
- Complimentary subscription to *Tunneling & Underground Construction* magazine
- Membership Directory
- Discounts on all SME publications
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- Link from SME website member page to your company's homepage
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#### SUSTAINING MEMBER BENEFITS — $1,500

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- Membership Directory
- Discounts on all SME publications
- Discounts on SME meetings, conferences and short corses including NAT & RETC
- Link from SME website member page to your company's homepage
- Access to SME comprehensive website

Membership was recommended to me by: _____

## Signature (All Applicants)

If elected, I agree to abide by the bylaws and rules of the Society for Mining, Metallurgy, and Exploration, Inc. as the same are now in effect and as they may hereafter be modified while I am a member. I understand that under certain laws and regulations, SME must have my permission in order to communicate with me via fax or email. I hereby give SME Foundation, SME Local Sections and SME business associations permission to send me information and advertisements. If SME does NOT have your permission to communicate with you via fax or email, you may not have access to some of your electronic member benefits.

Signature: _____ Date: _____

## Record of Experience

Include most recent record of employment as related to minerals industry.

| | | *Position of Responsibility* |
|---|---|---|
| From: | Title: _____ Employer: _____ | ☐ Yes ☐ No |
| | Nature of employer's business: _____ | |
| To: | Primary responsibilities: _____ | |

## Education

Please list **highest** degree earned, major, and date of graduation. Student Members must be full-time students at a school approved by SME and must indicate expected date of graduation.

Name of School: _____

Date of Graduation or Expected Date of Graduation: _____

Degree Earned: _____ Major: _____

## Endorsement (Student Members Only)

Student Member applications must be endorsed by an SME Professional Member.

Name: _____ Member #: _____ Date: _____

## Divisional/Technical Interest

Please indicate, in order of preference (1, 2, 3), a minimum of one and no more than three, technical interest categories.

**Divisions:**

_____ Coal & Energy (F)
_____ Environmental (E)
_____ Industrial Minerals (H)
_____ Mining & Exploration (Metallics) (A)
_____ Mineral & Metallurgical Processing (B)
_____ Underground Construction Association (U)

**Technical Interest Committees:**

_____ Bulk Material Handling (M)
_____ Construction Materials & Aggregates (O)
_____ Education (J)
_____ Minerals Resource Management (K)

## Industry Sector

☐ Underground Construction/Tunneling (11)

## Job Title

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☐ Educator (D)
☐ Engineer (E)
☐ GM/Vice President (G)
☐ Geologist (H)
☐ Marketing/Sales (M)
☐ Mine/Plant Manager (N)
☐ Owner (O)
☐ President/CEO/COO (P)
☐ Purchasing Agent (R)
☐ Scientist/Researcher (S)
☐ Student (T)

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Rev. 12/08

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## Corporate/Sustaining Member Contact Information

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Name: _____

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Telephone: _____ Fax: _____ Email: _____

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**4.** Name: _____

Job Title: _____

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Job Title: _____

Preferred Address: _____

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