T&UC

TUNNELING & UNDERGROUND CONSTRUCTION

THE OFFICIAL PUBLICATION OF UCA OF SME   WWW.TUCMAGAZINE.COM   VOLUME 4 NO 1   MARCH 2010

East Side Access Project: Work in progress

Controlling storage tunnel surges

Shaft design highlights Fox Conference

Tunnel Demand Forecast

Special Editorial Section from the publisher of *Mining Engineering*

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COVER STORY

CONTENTS — New York's $7.3-billion East Side Access project is designed to relieve congestion at Penn Station by carrying an estimated 160,000 commuters a day to Grand Central Station, saving them between 30 to 40 minutes of commuting time. *T&UC* Senior Editor William Gleason visited the project. Cover photo by MTA/ Patrick J. Cashin.

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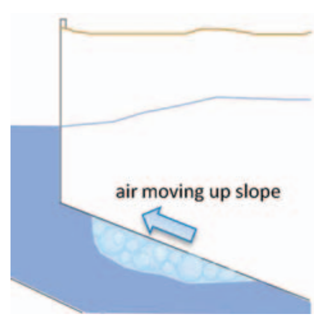

Special editorial section from the publisher of *Mining Engineering*

DEPARTMENTS

CHAIRMAN'S COLUMN

2010 started well for UCA of SME, and the future looks bright

I am pleased to report that the George Fox A. Conference held on Jan. 26, 2010 in New York City was a success for the UCA of SME. We had a record attendance of more than 300. I want to thank Hugh Lacy, chairman of the George A. Fox Conference Committee, and his fellow committee members for their time and effort in making this a successful event. The conference had very good presentations. But it also serves a much larger purpose, as this conference has become an important event for the meeting of the various contractors, design engineers, subcontractors and suppliers involved in the underground heavy construction industry in the eastern United States. Lacy and his committee are already working on the 2011 conference.

Please be advised that the UCA North American Tunnel (NAT) Conference is scheduled for June 19 to 24, 2010 in Portland, OR. Mark Ramsey, NAT 2010 Conference Chairman, and his committee have assembled a very interesting and educational program. The conference has booked all of the available exhibitor booths and, thus, we should have interesting displays on new technology for the industry. I would request that your company participate in the conference, as this does help our organization. With the many current and upcoming industry projects, I would suggest that you send younger people from your company. This will be a good venue for them to meet other industry people and to see new technologies. This is not just a conference for the "gray hairs."

If you plan to attend, make plans to attend the Scholarship/Awards Dinner on Tuesday, June 22. At this dinner, we will give out our various awards for Life Time Achievement, Person of the Year, Educator of the Year and Project of the Year. And an interesting dinner speaker is scheduled. This dinner is very important to the UCA's efforts to continue to grow its scholarship fund, as we feel that we must encourage young people to consider our industry as a life choice and then assist them during their educational endeavors. During the January 2010 Executive Committee Meeting, we voted to fund scholarships for 2010. Applications will be available on the UCA website. Our scholarships will not be limited to four-year degree candidates. They will also be available for two-year associate degree candidates.

If you would like to contribute directly to the UCA of SME Scholarship Fund, contact Mary O'Shea at the UCA of SME (phone 303-948-4211, e-mail oshea@smenet.org) in Littleton, CO. This is a tax-deductable contribution and you will be forwarded documentation for tax purposes. I have contributed to the fund and request that your company participate, if possible, as this is one way to assist in the recruiting and training of our next generation.

The underground heavy construction industry continues to remain strong, as major projects have come out for bid in the first and second quarter of 2010. Major tunnel projects will be bidding in San Francisco, CA, Columbus, OH and New York, NY. I recently wrote an article about our industry at the request of *ENR* and it was published in the Feb. 1, 2010 issue. I see the outlook to be very positive for 2010 and 2011 for all sectors of our industry, as there are numerous project design opportunities, projects are going to construction and the contractors are buying new equipment. The key challenge will

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David R. Klug,
UCA of SME Chairman

Four teams qualify to bid on Alaskan Viaduct

Four design teams have qualified to submit proposals for the Alaskan Way Viaduct bored tunnel project to Washington's state Department of Transportation. They are:

- AWV Joint Venture, a group with Omaha-based Kiewit Pacific Co. and German-based Bilfinger Berger Ingenieurbau.
- Seattle Tunneling Group, made up of S.A. Healy Co. from Lombard, IL.; Spain's FCC Construccion; S.A. Parsons Transportation Group, Inc., which has a Seattle office and Halcrow, Inc., which has an office in Vancouver, B.C.
- Vinnci/Traylor/Skanska (VTS JV) made up of VINCI Construction Grand Projects, a French Company; Traylor Bros., Inc. of Evansville, IN and Skanska USA and Arup, both of which have Seattle offices.
- Seattle Tunnel Partners (STP) made up of Dragados-USA, from New York, and HNTB Corp.

The four teams will receive a request for proposals in the spring. The proposals, to be submitted next fall, will detail the firms' plans for completing the tunnel design, constructing a tunnel boring machine and building the tunnel, including the interior roadway, tunnel systems, ventilation buildings and portal connections. The contract is estimated at approximately $1 billion, the *Seattle Times* reported.

"We are very pleased with the quality of the contractor teams vying for this project," said Paula Hammond, Washington Transportation Secretary. "Their worldclass expertise will be invaluable as we identify innovative ways to deliver the tunnel on time, within budget and with the highest level of quality."

Earlier this year, the state, county, city and Port of Seattle recommended replacing the viaduct with a bored tunnel beneath downtown Seattle. The plan includes a new waterfront roadway and public open spaces, transit investments, a new central waterfront sea wall and city street improvements. Environmental review of the proposed bored tunnel is under way and a supplemental draft environmental impact statement will be available this year. ■

First phase of New York's No. 7 subway line completed

On Dec. 21, 2009, New York City Mayor Mike Bloomberg and the New York's Metropolitan Transit Authority announced the completion of the first phase of the Number 7 subway line extension.

The second of two tunnel boring machines (TBM) reached the southern wall of the 34th Street Station cavern after mining a combined 880 m (2,900 ft) from their starting point at 26th Street under 11th Avenue.

The New York City-funded, $2.1-billion extension of the 7 Line is the first subway expansion in the city in decades and will help turn the Hudson Yards vicinity into a vibrant 24-hour neighborhood, containing a mix of commercial, residential, retail, open space and recreational uses.

Tunneling north from 34th Street presents unique challenges, as track will run under the 8th Avenue Subway, Amtrak/NJ TRANSIT tunnels, tunnels to the former New York Central Line, the Lincoln Tunnel and the Port Authority Bus Terminal and ramps. Excavation and underpinning of the 8th Avenue Subway line is under way to allow the new tunnels to tie into the existing 7 line tail tracks at Times Square.

Tunneling will be completed in the spring of 2010 when work will commence on station entrances and finishes, as well as support facilities such as ventilation and traction power substations. The new service will open in December 2013 as scheduled.

Construction of the tunnels and the 34th Street Station cavern is being done by S3II Tunnel Constructors, a joint venture of J.F. Shea Construction, Inc., Skanska USA Civil Northeast, Inc., and Schiavone Construction Co., Inc.

In January 2005, the city council approved the Bloomberg Administration's plan for rezoning the Hudson Yards area, including the Eastern Rail Yards.

In December, the plan to revitalize a stretch of land along Manhattan's west side waterfront was approved by the council, but the project remains without financing and it will likely be many years before any buildings go up.

The city council approved a rezoning plan for half of the 10.5 hm^2 (26-acre) rail yards known as Hudson Yards for apartments, hotel space, parks and other development, which is the last step of public approval for the entire project.

The other half was rezoned in 2005, but the developer and the transit agency owner have yet to close on a lease and construction has not begun.

The Metropolitan Transportation Authority owns the land and selected the developer, the Related Companies, in 2008. The property is now used for Long Island railroad operations.

The plan requires multibillion-dollar platforms to be constructed over the rail yards before construction can take place. That will not start until at least 2011.

The first half of the project, rezoned several years ago, allows for office, hotel and retail space, as well as public open areas. ■

Construction of Mexico's largest TBM is completed

In January 2010, Mexico City officials celebrated the completion of the country's largest ever tunnel boring machine (TBM) with a cutterhead turning ceremony. The 10.2-m- (33.5-ft-) diameter Robbins earth pressure balance (EPB) machine began excavation in the first week of February, Robbins reported in a release. The 7.7-km- (4.8-mile-) long tunnel for the Mexico City Metro represents the first new route in 10 years, and will service thousands of passengers daily.

The giant machine for the ICA Consortium (ICA, CARSO and Alstom) was assembled at the jobsite in a 17-m- (55.7-ft-) deep launch shaft. Crews assembled the machine in a concrete cradle at the shaft bottom, using gantry cranes to lower in components including the forward and rear shields, cutterhead and screw conveyor. Testing of all subassemblies is currently under way.

The machine is the first-ever EPB TBM to be assembled at the jobsite using onsite first time assembly (OFTA). The Robbins-developed process allows TBMs to be built initially on location, rather than in a manufacturing facility — a process that eliminates in-shop assembly and disassembly time as well as costs for shipping larger, partially assembled components. "With proper project management and fit up of components, OFTA can save about 70 to 80 percent of the time required for a similar assembly at a shop," said Ismail Benamar, tunnel manager for ICA.

The small launch shaft, approximately 34-m- (112-ft-) long by 14-m- (46-ft-) wide, is located in one of the most densely urban areas of the city. Machine launch in the tight space will require the TBM to excavate the first 70 m (230 ft) of tunnel using umbilical cables connected to backup gantries on the surface. Gantries will be lowered into the shaft successively as the machine bores forward.

Ground conditions in Mexico City are unique, requiring extensive vibration monitoring. Layers of clay, sand and boulders up to 800 mm (30 in.) in diameter are expected, as the area is part of a drained lake bed. The machine is uniquely designed to fit the conditions, utilizing a two-stage, 1,200-mm- (4-ft-) diameter ribbon-type screw conveyor to handle the large boulders. The machine will also feature active articulation, used to prevent deformation of the segment rings on curves as small as 250 m (820 ft).

In 2007, the Mexican Federal District announced plans to build Line 12 of the Mexico City Metro. Due to go online in 2011, the 24-km- (15-mile-) long route will pass through 22 new stations between Tlahuac and Mixcoac neighborhoods. The Mexico City metro is one of the world's largest, with more than 200 km (125 miles) of rail and nearly four million passengers daily. ■

CHAIRMAN'S COLUMN

Continued from page 2

be to maintain the funding sources for the major projects in a volatile political environment.

I am frequently asked if the stimulus funds from the American Recovery and Reinvestment Act (ARRA) are benefiting our industry. The Obama administration recently announced that $8 billion of these funds will be used to develop high-speed rail corridors in certain parts of the country. This should be very good for our industry. I know many tunnel design engineering companies that have been working on this program. It appears that some contracts will be awarded for studies and design but it will be many years until actual tunnel work will be performed. I am amused that this is called a "high-speed rail program." I have been on high-speed trains in Japan and France and the projects announced for the U.S. are not of this caliber. But, when in place, they should benefit our society.

The Canadian equivalent of the UCA, the Tunnel Association of Canada (TAC) is holding its conference in Vancouver, B.C. on May 14 to 20, 2010 in conjunction with the International Tunnel Association (ITA) World Tunnel Congress 2010. An interesting program has been compiled by the organizers. Since we are an international industry, it may be beneficial for you to send a representative from your company to this event. The website is www.ita-aites.org.

I want to thank Ray Henn and Jeff Petersen for assisting in the startup of the first UCA of SME Student Chapter at the Colorado School of Mines in Golden, CO. The first meeting took place on Nov. 17, 2009 and followup meetings with special tunnel industry programs have occurred. Brian Harris was named the chapter chairman and has worked very hard to make this a success. Please read the article in this issue for additional details. On behalf of myself and the Executive Committee, I want to thank everyone involved for their efforts to make this a success.

If any member or reader has any questions or comments on any of the above items or have suggestions on how the UCA can be of service to you or your organization, please call my office (724-942-4670) or e-mail me at dklug@drklug.com.

Tunnel picked for study in Sacramento

There may be another large tunneling project in the works on the West Coast. Officials guiding the Bay Delta Conservation Plan chose to study a tunnel option to ship Sacramento River water across the delta to Californians from Silicon Valley to San Diego, Sacramento's *Merced Sun-Star* newspaper reported.

The plan is an effort to secure California water supplies from environmental problems, flood risk and rising sea levels in the Sacramento-San Joaquin Delta.

About 25 million Californians and 809,000 hm^2 (2 million acres) of farmland depend on the delta for at least some of their water supply.

The decision targets the tunnel for more detailed study. It was not a decision to build a tunnel or to exclude other options.

The tunnel would be 69-km- (43-miles-) long. Over most of that length, there would be two parallel tunnels about 45 m (150 ft) underground, each 10 m (33 ft) in diameter.

The tunnels would rank among the largest of their kind in the world. Multiple tunneling machines would work simultaneously for about eight years, consuming $284 million worth of electricity.

The tunnels could move water at 425 m^3/s (15,000 cu ft/s), or 10 times the volume in the Tuolumne River. The estimated cost of the project could reach as much as $11.6 billion.

Water agencies that would benefit, notably those serving San Joaquin Valley farmers and the Metropolitan Water District of Southern California, have agreed to pay for it. The cost would be passed on to ratepayers.

"I believe it is a milestone that we just arrived at," said Karen Scarborough, undersecretary of California's Natural Resources Agency, who leads the group's steering committee. "It's a major thing that we just did." ■

Downtown Austin waste water project bid awarded to SAK Construction

SAK Construction will build a 5,670-linear m (18,600-l ft) relief tunnel as part of the 5.6-km (3.5-mile) waste water tunnel project in Austin, TX.

The relief tunnel will vary in diameter between 2.4 and 3 m (8 and 10 ft) and will accommodate sewer pipe ranging from 1.3 to 2.4 m (54 to 96 in.) in diameter. SAK is a national pipeline rehabilitation and tunneling industries contractor headquartered in the St. Louis, MO area. The contract is worth $31.9 million.

The downtown waste water tunnel project will expand the capacity of the waste water system to accommodate the continued growth and redevelopment of downtown and south Austin. The downtown waste water tunnel project is managed by the city of Austin Public Works Department. Project completion is scheduled for March 2012.

Recent SAK Construction projects include a CIPP sewer rehabilitation for the Los Coyotes water reclamation plant in Los Angeles County, CA.; serving as subcontractor for the CIPP portion of the Meadows Alta Parallel project for the city of Las Vegas, NV; a CIPP sewer rehabilitation for the city of Phoenix, AZ., totaling more than 36,575 lm (120,000 lft); a 10,360 lm (34,000-lft) CIPP sewer rehabilitation project for the city of St. Paul, MN.; and the 700-lm (2,300-lft), 2.4-m- (96-in.-) diameter Coldwater relief tunnel in unincorporated St. Louis County for the Metropolitan St. Louis Sewer District (MSD). ■

Secaucus JV lands MTT contract

The joint venture of Schiavone Construction Inc., J.F. Shea Construction Inc. and Skanska USA Civil Northeast Inc., called PTP Contractors of Secaucus, landed the second tunneling contract to be awarded for the $8.7 billion Mass Transit Tunnel project.

New Jersey Transit awarded the $258.8 million contract to PTP Contractors of Secaucus for the final design and construction of the tunnel through the Palisades between North Bergen and Hoboken, according to the NJ Transit board.

The Palisades portion of the project will span nearly 1.6 km (1 mile) from the Tonnelle Avenue underpass in North Bergen, to the Hoboken shaft. The latest contract is scheduled for completion in 2014, while the entire rail tunnel project is expected to be ready in 2017, according to NJ Transit.

OHL USA/Tully Construction was second at $303.7 million followed by ARC Constructors (Healy/CCA Civil/Halmar International) at $309.8 million.

The Palisades segment involves the construction of twin 1,585-m (5,200-ft) bores on the New Jersey side of the Hudson. Prequalification for the third and final tunnel segment – the Hudson River segment – is under way with an award expected in the fall.

Earlier in December, NJ TRANSIT authorized the award of a $583-million contract to a joint venture of Barnard of New Jersey and Judlau Contracting Inc. of College Point, N.Y., the lowest of three bidders for the 1.6 km (1 mile) Manhattan segment. ■

First major Mass Transit Tunnel contract awarded

The joint venture of Barnard and Judlau Contracting Inc., won the first major bid of the Mass Transit Tunnel (MTT), the largest public transit project in the United States that will double commuter rail capacity between New York and New Jersey.

Barnard, of New Jersey, and Judlau, of College Point, NY., brought the lowest of three bids for the construction a 1.6-km- (1-mile-) long tunnel segment in Manhattan — one of the MTT project's three tunnel segments.

The $583 million contract was awarded by the NJ Transit (NJT) board of directors.

"By improving this critical transportation corridor, we are ensuring that our tunnels remain a source of economic strength and mobility for New Jersey and the region," said New Jersey Gov. Jon S. Corzine. "This contract will provide an immediate boost to our economy with the Manhattan and Palisades tunnel segments expected to generate approximately 1,000 jobs and the Mass Transit Tunnel project as a whole creating many more jobs over the next several years."

NJT expected to receive bids for the Palisades tunnel segment, followed by the third and final Hudson River segment.

The Manhattan tunnel segment is part of an overall project to build two new single-track commuter rail tunnels under the Hudson River, doubling capacity of the two-track tunnel that was built 100 years ago, and which operates at its functional capacity today. The other main feature of the project is construction of an expanded New York Penn Station specially designed to handle the customer surges associated with a commuter railroad.

"This project positions NJ Transit to respond effectively to the demands of New Jersey residents for 21st-century transportation options that decrease our reliance on fossil fuel while improving the environment," said Transportation Commissioner and NJT chairman Stephen Dilts.

The project is being built by NJT in partnership with the Port Authority of New York & New Jersey.

The additional commuter rail capacity provided by the new tunnel will remove an estimated 22,000 vehicles from regional roadways each day.

The project is expected to generate and sustain 6,000 jobs annually in peak construction years and create 44,000 permanent jobs after completion.

The Manhattan tunnels segment will be constructed under a design-build contract that includes final design and construction of rail tunnels that will extend a distance of approximately 1.6 km (1 mile) from a shaft at 12th Avenue and 28th Street in Manhattan.

Construction is expected to continue through late 2013.

The contractor will construct a 49-m- (160-ft-) diameter access shaft on the western edge of Manhattan, and then bore 5,000 m (16,500 ft) of tunnels averaging more than 36 m (120 ft) beneath the surface to a new expansion of Penn Station under 34th Street between 8th and 6th avenues.

The twin tunnels will be located an average of 36 m (120 ft) below street level and will proceed diagonally northeast then eastward and split into four tunnels to maximize train movements in and out of the expanded New York Penn Station as the tunnels approach 34th Street.

The contractor will perform the excavation using two tunnel boring machines, each about 8 m (27 ft) in diameter. The total length of the machine-bored tunnels included in this contract segment is 5,000 m (16,500 ft).

The MTT will double service capacity to 48 trains per hour during peak periods from the current 23 trains. Twice as many passengers will be able to be accommodated, from 46,000 each morning peak period now to 90,000 in the future. The project will also create transfer-free, one-seat rides for travelers on 10 of NJ Transit's 12 rail lines.

The Port Authority is contributing $3 billion toward the MTT project cost, while the federal government will contribute $3 billion under its "New Starts" transit funding program. Another $2.7 billion will come from a combination of other federal funds, including stimulus and clean air funding, as well as the New Jersey Turnpike Authority's congestion mitigation contribution. ■

Credit for the photo of the 7 Line Extension in New York City, on the back cover of the 2010 UCA of SME calendar, was inadvertently omitted. Photo credit should be given to MTA/Patrick J. Cashin. SME apologizes to Mr. Cashin for the error.

T&UC BUSINESS PROFILES

A special advertiser sponsored advertorial section

MARCH 2010

Underground Construction and Tunneling history is made by the investment of companies worldwide that dedicate their efforts and vision to the advancement of the industry.

SME and T&UC acknowledge these companies that demonstrate a continued focus on providing the world with the best in underground technology, products and services.

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Fletcher engineers spend more time in the field, listening to customers telling what they like – and don't like – about mobile equipment. How can operations be made more efficient? How can operators be kept safer, or more comfortable? Some of our best ideas begin when a customer asks, "Why can't..?" This eagerness to solve customer problems sets Fletcher apart.

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Jennmar – World Class in Ground Control Technology

Frank Calandra Jr. – President

Jennmar is a multi-national company owned and operated by the Calandra Family. Frank and Jack Calandra are the two common stockholders. In 1972 Frank Calandra shifted Jennmar's focus to manufacturing ground support products for the mining and tunneling industry.

Over the years most of Jennmar's growth has been internally driven. The company currently owns over 80 patents relating to ground support applications. The majority of Jennmar's ten plants have been built exclusively by Jennmar. We maintain eight steel related bolt plants, located throughout the Appalachian, mid-west, and western coal fields. All of them are within two hours of our major customers.

During the late 1990's and into this century, we have been aggressively transplanting our values and technology in the international markets. Currently we have manufacturing facilities in Sturgeon Falls, Ontario; Sydney Australia; Paget, Mackay, Queensland, Australia; and Jining City, Shandong Province, China. Jennmar has two more international expansions coming in 2010 and 2011. This includes, moving from a small, leased space in Sturgeon Falls, Ontario and into our new 50,000 square foot building also located in Sturgeon Falls. Jennmar is also in the process of opening a new facility in Santiago, Chile.

In 2006, we entered the resin market making Jennmar a complete provider of strata-control products. We are the only manufacturer that maintains our resin plants on the same property as our bolt plants emphasizing optimal steel and resin delivery. Today, we maintain three resin plants located in Pennsylvania, Kentucky, and Sydney Australia.

The majority of our steel bolt plants are fed flat stock from our large steel processing plant located on Nucor Steel's Berkley Campus, near Charleston, South Carolina.

Tony Calandra – Executive Vice President

As a company we believe that our most important asset lies in our 1500 dedicated employees. We believe in developing a closeness to our customers by keeping the lines of communication open at all levels. We believe that hard work on our part is as important as the quality of products we sell. We are a customer-oriented company. It's the only way we do business.

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Messinger Bearings – A Kingsbury Brand

Messinger Bearings is one of an elite few companies in the world capable of producing large, custom-designed bearings in limited quantities for tunnel boring machines (TBMs). In its new business model, Messinger is addressing the challenge from most end users today about how to get new or repaired bearings of this size delivered in a reasonable timeframe. Customers who purchased 3-row TBM main bearings from competitors just a few years ago took delivery within about eight to nine months. Since then, deliveries have stretched out to 18 to 24 months, or longer. Why the big difference? Many of these manufacturers have shifted their attention to the high volume bearing business and away from small quantity custom applications. Not so with Messinger Bearings.

TBM Bearing Customers Have an Option

Based in Philadelphia, Messinger Bearings was established in 1912 as a designer and manufacturer of large, heavy duty rolling element bearings. Today, Messinger Bearings focuses on providing large diameter custom bearings for unique applications, including those found in much of the TBM equipment. Messinger can now manufacture new bearings to 25 ft in diameter, as well as repair them. In fact, Messinger is one of the few bearing manufacturers in the United States capable of turning bearings of this size. Messinger's manufacturing facility has recently been expanded to include a new state-of-the-art CNC vertical boring mill along with new induction heat treat capabilities.

New or Rebuild? Your Choice

Deliveries for 3-row TBM main bearings have been a recurring challenge for TBM customers. Given the increased focus for renewable energy, this will likely get worse. Messinger chooses not to participate in the wind energy business because it does not enable the company to support its current customers and its core business, that is, large heavy-duty custom bearings for specialty applications in limited quantities. Aside from new bearings, many of Messinger's customers ask us to repair their existing bearings.

For example, a TBM project was recently under way and the spare bearing was found to have a broken outer race. In addition to manufacturing a new outer race, Messinger was able to repair the entire bearing in more than enough time to have it on site when needed. Considerable savings were realized, not only with the repair itself but also by limiting downtime.

TBM Bearings and More, Planning for the Future

Messinger has recently expanded its capacity to manufacture and repair bearings up to 25-ft OD for TBM and other custom applications. Aside from equipment capacity, additional personnel for engineering and design, metallurgy and manufacturing have been and continue to be added to the team. In addition to the large 3-row and other style cylindrical roller bearings, Messinger is also now well positioned to repair and manufacture new large bore tapered roller bearings.

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www.messingerbearings.com

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- **Condat** – Ground Conditioning Chemicals and Lubricants
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- **Damascus** – Underground Supply & Personnel Vehicles
- **Dywidag** – Bolts and Accessories including DSI Threadbar, Friction Bolts and Omega Bolts
- **Geodata** – Monitoring Equipment
- **Hany** – Grouting Systems
- **MAI Systems**
- **Muhlhauser** – Rolling Stock
- **Promat International** – Fire Protection Products
- **Sika** – Additives and Admixtures
- **Trelleborg** – Tunnel Segment Gaskets
- **Tunnel Tec** – TBM Cutting Tools
- **VikOrsta** – CT-Bolts – Double Corrosion Protection
- **Weldgrip** – Fiberglass Bolts and Dowels
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Robbins Revolutionizes Soft Ground Tunneling

The Robbins Company, the world's foremost supplier of advanced, underground construction equipment, is now offering soft ground TBMs worldwide. Robbins Earth Pressure Balance Machines (EPB TBMs) are now making swift headway on a dozen projects in multiple countries. Although known in the industry for its hard rock machines, innovative machine designs are expanding the company's product offerings to now include machines for mixed ground and soft soils at high pressures.

Over 50 years of Experience

In 1952, James S. Robbins developed the first rock tunnel boring machine in South Dakota, after witnessing the relatively slow rates achieved by a prototype drilling and blasting machine. Subsequent TBM designs, at the Humber River Project in 1954, saw the first use of rolling disc cutters—the discs effectively excavated limestone up to 200 MPa (29,000 psi) UCS.

From those inventive beginnings, The Robbins Company has grown into an international supplier of underground equipment, with foundations in the soft ground, hard rock, and trenchless construction markets. Today, 12 offices and 22 representatives are located in 28 countries around the world, with many local offices providing comprehensive support on regional projects.

Rapid Excavation

Throughout 2009 Robbins Earth Pressure Balance Machines have exceeded project requirements, achieving dozens of project records. In the U.S., a 4.25 m (13.9 ft) diameter EPB is boring the Upper Northwest Interceptor Sewer in Sacramento, CA, has realized rates of 210 m (690 ft) during multiple weeks, all while simultaneously erecting a PVC-embedded concrete liner never before used in North America.

Overseas, two 6.3 m (20.7 ft) diameter Robbins EPBs boring China's Guangzhou metro set an astounding 16 project records in some of the country's most challenging geologic conditions. The machines set records of up to 377 m (1,235 ft) per month in silt, sand, highly weathered granite, and hard rock—rates higher than any of the other 16 machines boring on the project.

In 2010, Robbins will launch three 8.9 m (29.3 ft) diameter EPB TBMs for Mexico's largest infrastructure project—the 63 km (39 mile) long Emisor Oriente waste water tunnel. The tunnel will add much needed capacity to Mexico City's aging and deteriorated sewage system.

A fourth 10.2 m (33.5 ft) diameter machine will excavate a new metro line through the heart of Mexico City after its assembly at the jobsite. Onsite First Time Assembly (OFTA) is a process developed by Robbins to save both time and money to the contractor. By initially assembling the machine onsite, rather than in a manufacturing facility, shipping costs and man-hours required for disassembly are eliminated. The results often yield an assembly schedule several months shorter and high dollars in savings.

Robbins innovations will continue to advance in 2010, with major EPB projects planned for launch in the Dominican Republic, Azerbaijan, India, and China. For more information on recent tunneling and groundbreaking R&D, visit www.TheRobbinsCompany.com or call +1 440 248 3303.

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North America's Leader in Geotechnical Construction

However difficult the ground, only Hayward Baker, North America's leading specialty geotechnical construction contractor, has the diversity of ground modification techniques to solve your geotechnical problem. Tunneling services include: Earth Retention, Underpinning, Waterproofing, Bottomseals, Soil Improvement, and Ground Stabilization.

Hayward Baker has worked on hundreds of tunneling projects and has the right tools and experience for yours.

Seattle, WA
Brightwater Conveyance System

Construction of the Brightwater Conveyance System required surgical jet grouting to facilitate tunneling operations. Utilizing their proprietary jet grouting equipment, Hayward Baker created soilcrete blocks outside of four deep vertical shafts to assist with both TBM and handmined tunneling operations. The ground improvements allowed TBMs to be launched or received into and out of the shafts without the risk of water and ground run-in. Overlapping columns to depths up to 94-feet compose the soilcrete blocks.

Brightwater Conveyance System

Los Angeles, CA
Lower North Outfall Sewer Rehabilitation Project

Rehabilitation of the 82-year-old Lower North Outfall Sewer included grouting around the outside of the tunnel to densify and strengthen the soil above the tunnel in order to protect the overlying structures from settlement. Hayward Baker performed permeation and fracture grouting through over 3,500 holes from within the tunnel, stabilizing the overlying structures. State-of-the-art survey technology and proprietary grouting instrumentation allowed Hayward Baker to first probe the soil to determine existing conditions, and then observe the soil response during grouting while monitoring the ground surface in real time.

Lower North Outfall Sewer

Los Angeles, CA
East Central (ECIS) & North East (NEIS) Interceptor Sewer Tunneling Projects

Extensive tunneling operations for ECIS and NEIS required numerous ground modifications. Hayward Baker provided chemical grouting and microfine cement grouting for four shaft break-ins, five major freeway over-crossings, 27 manhole connections, and six major or sensitive utility crossings as well as for a major siphon structure and hand-mined access shaft, founded in silty soils containing less than 35% fines.

Other ground modification included locating and filling an abandoned water tunnel, and compaction grouting.

Los Angeles, CA
Metro Gold Line C800

Construction of twin subway tunnels for the LA Metro's Gold Line would cause ground loss, endangering overlying structures unless the soils surrounding the tunneling zone were treated prior to excavation. Using conventional horizontal drilling to install steel and PVC sleeve port grout pipes, Hayward Baker performed chemical grouting to stabilize soils and soilfrac compensation grouting to protect overlying structures. Heave and settlements were monitored by exterior remote robotic total stations and interior wireless tiltmeters.

Metro Gold Line

St. Louis, MO
Baumgartner Tunnel Alignment

Water-bearing rock formations in the path of the Baumgartner Tunnel Alignment needed to be sealed. Unsafe levels of hydrogen sulfide forced the grouting to be performed from the surface in advance of the tunneling operation. Hayward Baker drilled and grouted the water-bearing rock formations along a 1,200-ft long segment of the proposed 20,000-ft long, 12-ft diameter combined sewer tunnel. A total of 40,000-feet of grout holes were drilled to complete the project. Depths of the drill holes were approximately 170-ft from ground surface.

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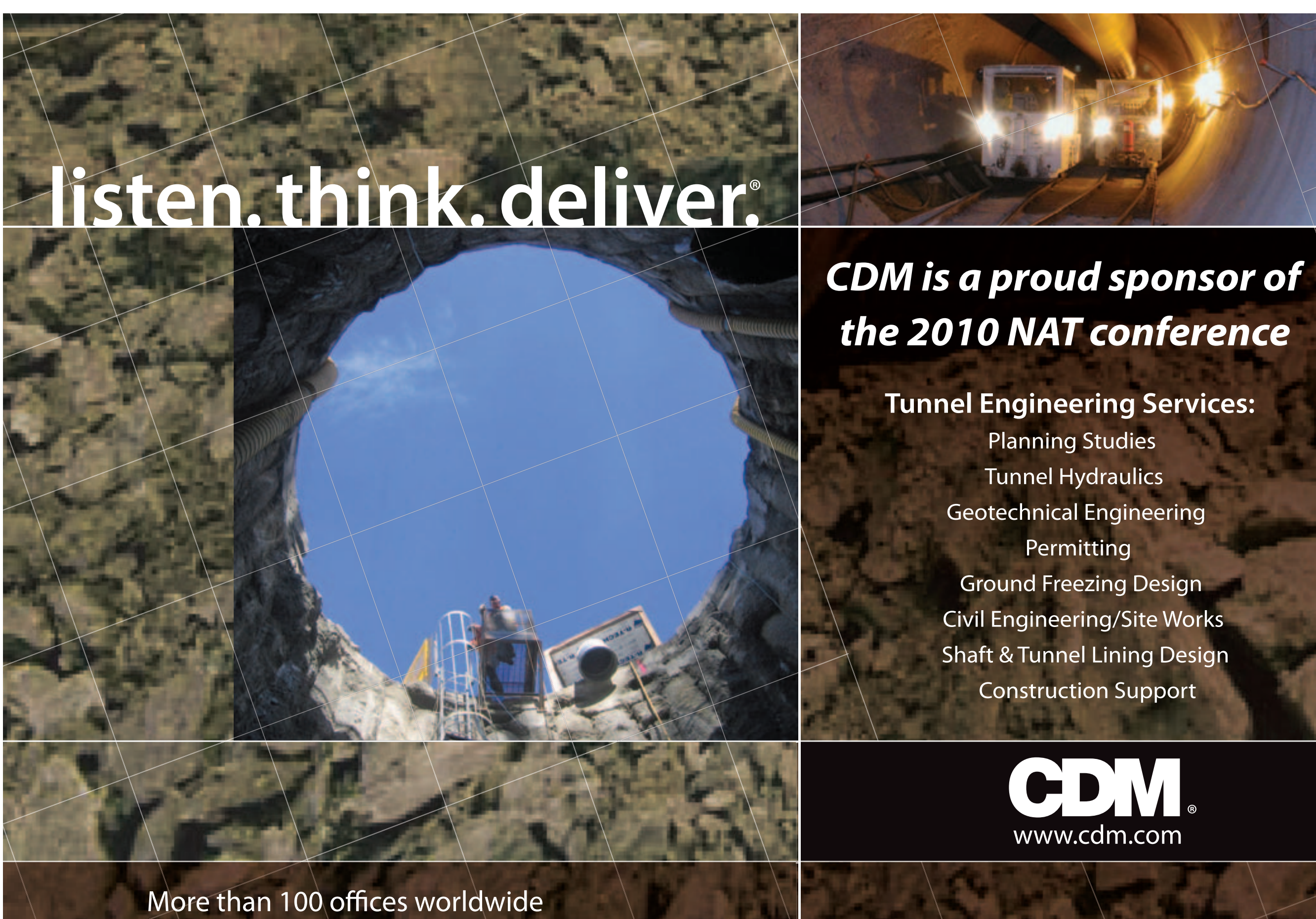

Normet in North America - Equipment and Vehicles for Tunneling and Mining

Normet provides solutions for selected, demanding customer processes in underground mining and tunneling.

For over 45 years we have developed, manufactured and marketed equipment and vehicles for underground applications. In addition, we provide a comprehensive range of Life Time Care services e.g. maintenance, service programs, spare parts and training around the equipment and the processes they are used for. With over 7500 delivered machines we have became one of the market leaders in our product areas.

One of Normet's key missions is to improve the safety and efficiency of workers underground, through equipment targeted to the work processes of:

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- Explosive Charging
- Lifting and Installation
- Underground Logistics
- Scaling

In North America, Normet is headquartered in Union Grove, WI, USA (Normet Americas, Inc.), operates in Canada from our new location in Sudbury, ON (Normet Canada, Ltd.), and offers representation (Minas y Tuneles) in Mexico. We have sales and field service professionals in a number of locations across the continent, and operate a comprehensive parts management program with stocking in various locations to ensure an efficient means of distribution to our customers.

We are supported by our global head office in Finland (Normet Line Production, R&D and Group functions), Semmco Line Production in Santiago de Chile, and Sales, Marketing and Product Offering Development are headed from Switzerland, from where we manage our customer interface processes. And with global customer satisfaction in mind, we now employ over 450 business professionals in 23 locations worldwide.

Normet understands not only the equipment we manufacture but the rigors of the customers' underground processes for which they are designed.

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A Century of Shotcrete Solutions

Allentown Shotcrete Technology, Inc. is celebrating its 100th anniversary in the sprayed concrete industry.

In the early 1900s, Allentown's pioneering technology was first developed for taxidermy purposes when its originator, Carl Akeley, a famous hunter and professor, devised a method for spraying plaster onto a wire frame. The outcome was a strong, thick plaster coating that didn't slump from the frame or set before being fully placed.

Forty years later, a new process was developed involving the use of pressure tanks to force stiff mortar through a hose. This new wet-process became known as shotcrete – and the rest is history.

"In this day and age, very few companies are able to succeed in business for 100 years," says Patrick Bridger, President of Allentown. "We are very proud of our longevity, and see it as a testament to our reputation for quality, and the value we have brought our customers for a century."

Since the 1950s, the Allentown name has been synonymous with the process of spraying mortar at high velocity onto surfaces in the refractory, underground, mortar and civil industries. The Allentown equipment line has expanded to include a wide range of Gunning Machines, Pre-dampeners, Pumps, Combination Mixer-Pumps, Mixers, Chemical Additive Pumps, Nozzle Carriers, Mortar Machines, Concreting Machines and parts and accessories.

Throughout the years, Allentown has experienced numerous milestones, which have strengthened its position in the market. To find out more about these milestones and Allentown's century of experience, visit www.allentownshotcrete.com or call (800) 553-3414.

Allentown Shotcrete Technology, Inc.
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Surecrete Inc. specializes in furnishing bagged cementitious materials, mixing and placing equipment, and related accessories to the heavy civil tunnel, geotechnical and mining markets. Our product lines include Nittetsu Super Fine ultrafine cement, rheology modifiers, specialty admixtures, and a complete selection of packaged wet and dry shotcrete, concrete and grout mixes. We also represent several major equipment manufacturers specializing in the mixing and placing of shotcrete, concrete and grouts. For more information, visit our web site at www.surecrete.com

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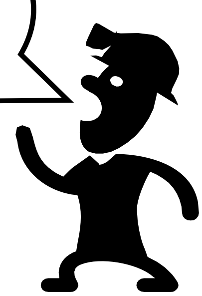

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Mining Equipment – Serving the Industry for Over 25 Years

Mining Equipment 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 rolling stock, C. S. Card and Moran Engineering and new ventilation equipment, Jetair fans.

Mining Equipment specializes in rolling stock. They have more than 300 diesel, battery and trolley locomotives in stock. Plymouth, Clayton, Brookville, Schöma, Goodman, Greenburg and General Electric locomotives are all in inventory. They have a huge inventory of muck cars, flat cars, mantrips, and specialty rolling stock ready to be rebuilt. Mining Equipment also builds new rolling stock to meet customer needs.

Mining Equipment builds new Jetair Axiflow Fans up to 500 horsepower and 84-inch diameter. They developed a line of Super-Silenced™ Fans that run quieter and take up less space than other integrated fan and silencers. They also roll steel ventilation ducting on-site. Ducting as small as 12-inch and as large as 84-inch can be rolled.

Mine Hoists International is a fully-owned subsidiary of Mining Equipment. Based in North Bay, Ontario, Mine Hoists boasts the largest selection of used mine hoists and stage winches in the world. MHI has more than 35 mine hoists in inventory and 60 stage winches up to 80,000 lbs. capacity.

Mining Equipment, Jetair and Mine Hoists International are currently doing business in North and South America, Australia, Asia, Africa and Europe. To learn more about Mining Equipment, visit their website at: www.miningequipmentltd.com or www.jetairfans.com.

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New York City Water System – Damascus Corporation

The New Croton Aqueduct went into service in 1890 with three times the capacity of the Old Croton Aqueduct. It supplies ten percent of New York City's water. Renovation of the New Croton Aqueduct began in 2009. In November, Frontier-Kemper Constructors, Inc. was awarded a contract by the Frontier-Kemper/Schiavone/Picone, JV for the design and fabrication of various shaft and aqueduct equipment while Damascus Corporation designed and manufactured transport vehicles for Frontier-Kemper. The MAC-2DT 4x4 diesel tunnel vehicle was developed to transport two pallets of material totaling 5000 lbs and allow the operator to easily steer in forward or reverse, a requirement as the tunnel has limited room to turn a vehicle around. Frontier-Kemper designed and fabricated movable work bridges that allow the 4 ft. wide vehicles to pass within the 12 ft., 3 in. I.D. brick lined aqueduct. The MAC-2DT comes equipped with an automatic fire suppression system, safety alarm, PTO, and forward and reverse cameras. The MSHA approved Deutz engine and four hydrostatic drive wheel units act as a transmission for smooth traveling while allowing for high ground clearance and room for the Air-Ride assisted heavy-duty leaf spring suspension. Damascus Corporation's MAC-4-ACT is a battery powered vehicle with seating for eight people and converts to haul six people and a pallet of supplies. The MAC-4-ACT uses a brushless AC motor that provides consistent torque throughout the battery discharge. No longer does battery charge determine battery speed. With the AC motor of the variable frequency drive, battery power is used efficiently to provide consistent and reliable transport.

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HIC Fibers, Inc. has opened offices in Los Angeles, California, for North America and Lima, Peru for Central and South America. This marks the first time that HIC Corporation, based in Korea, has opened offices with the intention of selling direct to the end user in lieu of selling strictly through distributors.

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Moretrench, headquartered in Rockaway, New Jersey, is a full-service geotechnical contractor specializing in design/build and turnkey solutions for challenging construction requirements and subsurface conditions.

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These services are available nationwide through full service offices in New Jersey, New York, Florida, Massachusetts, Pennsylvania, Delaware and Washington D.C. Moretrench is a USGBC member which oversees the LEED program.

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Jacobs Associates Breaks Ground

Jacobs Associates is leading the tunnel design on three major U.S. projects that recently bid: Bay Tunnel, Caldecott Fourth Bore, and University Link Light Rail. Bay Tunnel will provide 5 miles of new water supply conveyance between the East Bay and San Francisco Peninsula. It went to bid last fall, and construction begins in the spring. Also in the San Francisco Bay Area, portal construction of the Caldecott Fourth Bore Tunnel started in February and tunneling begins in June from each end of the new bore, with first highway traffic expected through the new tunnel in 2014. University Link Light Rail, which will shorten commute times by utilizing a completely underground alignment, broke ground last spring, with service slated to begin in 2016.

Jacobs Associates
Telephone: 800-842-3794
www.jacobssf.com

31 Years of Growth at Geokon

2010 marks Geokon Inc.'s 31st year of steady growth: Its main office in Lebanon, NH, USA is currently undergoing its fourth expansion with a 13,500 sq ft, two-story addition. The new facility will allow increased production and expanded capabilities in the latest data acquisition and communications techniques to further augment Geokon's Vibrating Wire Technology, in which they excel and foresee greater use in the years to come.

Geokon's President, Barrie Sellers, on the second floor of their new addition.

Geokon has 80+ employees—many of whom have been with the company for over 20 years. Their wealth of experience allows Geokon to quickly and effectively satisfy the most demanding geotechnical monitoring requirements. In addition, Geokon has a network of 40+ worldwide agents and has, through their efforts, participated in major Civil Engineering projects throughout the world.

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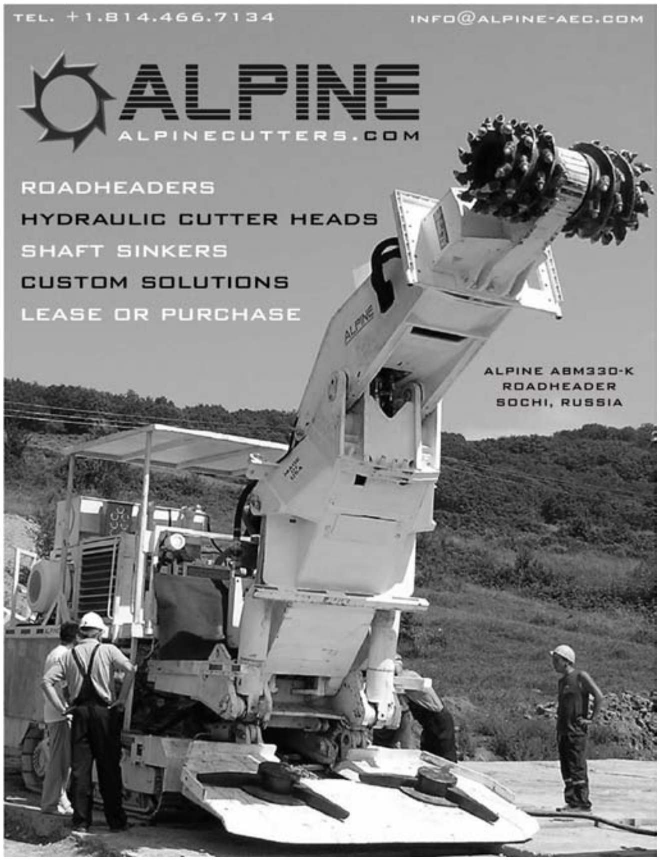

Engineering Solutions from Alpine

Since 1968 Alpine Equipment (State College, PA USA) has been a trusted builder and supplier of equipment for the tunneling and mining industries. Specializing in roadheaders, multi-tool-miners, shaft-sinkers, and hydraulic cutter head attachments; Alpine also provides custom engineering solutions. Rock excavation and tunneling equipment, both new and re-

built, is offered for lease or sale and is backed by one of the most experienced teams in the industry. Rugged enough for the most extreme applications and backed by experienced service personnel these rock cutters offer unmatched reliability and productivity. Product details online at www.alpinecutters.com.

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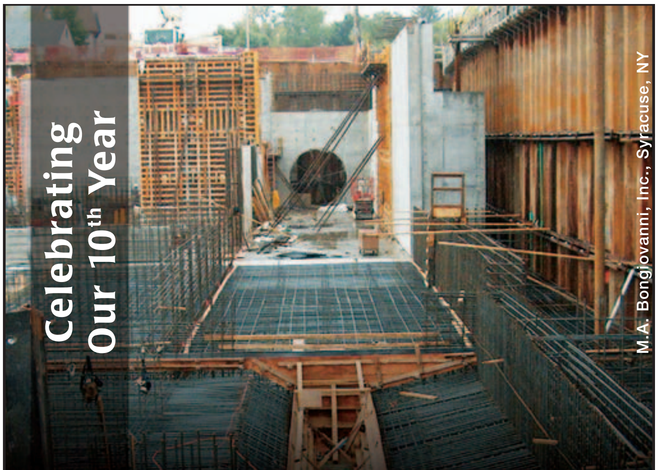

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FEATURE ARTICLE

East Side Access project taking shape beneath the streets of Manhattan

Beneath some of New York's most iconic buildings — The Met Life Building, the Helmsley Building, the Waldorf Astoria — crews are busily at work on the Metropolitan Transportation Authority's long-awaited East Side Access (ESA) project. In fact, it is 14 floors beneath the famed Grand Central Station where one of the centerpieces of the project, the new Long Island Railroad (LIRR) station terminal, is being blasted and carved into shape.

When completed in 2016, the $7.3-billion ESA project will increase LIRR's capacity into Manhattan and significantly relieve congestion at Penn Station. Currently, 37 LIRR trains per rush hour roll into the crowded Penn Station where many riders must then transfer to subway trains to complete their commute. When completed, the ESA tunnels will bring an estimated 160,000 riders directly to Grand Central Station, saving those riders 30 to 40 minutes. Studies have found that more people work within walking distance of Grand Central than Penn Station. "The benefits of the project are tremendous," MTA Capital Construction President Michael Horodniceanu told more than 340 industry professionals attending the UCA of SME's George A. Fox Conference in New York on Jan. 26. "The ESA is the first expansion of the LIRR in 100 years. It will increase the East River tunnel capacity by 50 percent and will help support job growth around Grand Central."

About 6,700 m (22,000 ft) of tunnels have been carved out of Manhattan schist for the East Side Access project in New York. Photo by William Gleason.

The new drop off and launching point in midtown east Manhattan for these commuters will be a pair of caverns 18-m- (60-ft-) wide, 18-m- (60-ft-) high and 365-m- (1,200-ft-) long with a 12-m (40-ft) center pillar linked by eight cross passages. These caverns are being built beneath Metro-North Railroad's lower level at Grand Central Station. Each cavern will have an upper and a lower platform that will be connected by a mid-level mezzanine and 17 escalators to the new LIRR concourse. The concourse is in the area of Metro-North's former lower level train storage yard, known as Madison Yard.

William Gleason, Senior Editor

To support Metro North's upper level, new structural steel columns have been put in place in the vicinity of the Park Avenue corridor. These columns allow for the safe removal of the existing support columns and will make room for excavation of four escalator wellways that will eventually provide access between the concourse and the caverns where LIRR trains come into the station. "At the end of the day, we will have 46 escalators and 13 elevators and 8,450 m^2 (91,000 sq ft) of public space," explained Horodniceanu. The terminal will include shops and restaurants, and pathways to Grand Central Terminal, the subway system and the street above.

The tunnels to the upper caverns have already been bored by a pair of tunnel boring machines (TBM) and crews are expanding the caverns with drill-and-blast and roadheaders. This work, at the center of one of the largest and most complex underground projects in the history of New York City, is just one of 15 contracts currently being completed. In all, 12 separate enlargements around previously mined TBM tunnels will take place on the Manhattan side of the project.

"We awarded more than $1 billion worth of work just last year," said Andy Thompson, East Side Access Program Manager for Hatch Mott MacDonald. "We got over a commitment hump."

On Feb. 3, Notice to Proceed on the final remaining

Workers pass through one of the tunnels beneath Manhattan. Photo courtesy of MTA/Patrick J. Cashin.

tunnel contract, the 36-m (120-ft) tunnel structure under Northern Boulevard that links to the 63rd Street Tunnel, was issued.

Construction of the line to Grand Central began in November 1969 when four premanufactured, four-chamber tunnel boxes were immersed in the East River for the subway and the LIRR. After a long delay caused by New York City's fiscal collapse of the 1970s, the 63rd Street subway line and LIRR tunnel were completed, but the lower level tunnels were never put into use. The current project has made use of those tunnels as they are currently being used to transport equipment into Manhattan and muck from the project out.

Tunnels

The East Side Access project is using two TBM's – a refurbished double shield Seli and a refurbished main beam gripper Robbins machine. Each machine has a 6.7-m- (22-ft-) diameter cutterhead.

Each TBM will make a total of four drives and will tunnel a total of 9,750 m (32,000 ft) beneath Manhattan. Beginning at 63rd Street and Second Avenue, the tunnels head southwest to East 59th Street, under New York City Transit's (NYCT) Lexington Avenue line. Each tunnel will bifurcate into two tunnels at 59th Street. The tunnels will continue south to 50th Street where they will bifurcate into eight tunnels on two levels through future LIRR station caverns to 43rd Street where they converge into four tunnels.

After each TBM completed its drive for the upper tunnels, it was backed out of the shafts, back to a position north of the future Wye/Interlocking Cavern, explained Mark Rhodes, lead quality engineer, Hatch Mott MacDonald. "A concrete plug was poured after the machine was extracted from the tunnel and we started mining through that and did the other drive of the cavern. When they finished that out, we backed the machine all the way back to where it splits to go underneath and did the same thing,"

As of Feb. 5, the Robbins TBM was beneath Park Avenue and 42nd Street with approximately 213 m (700 ft) left to mine while the Seli was being prepared for mining its next drive starting at Lexington and 59th Street.

In addition to the extremely complex engineering feats being completed on the project, there is also the challenge of logistics.

"Everything from here, all the muck, goes out to Queens," said Thompson. "There is 321,000 m^3 (420,000 cu yd) of rock that has to come out of the caverns. We can excavate it, but getting it out is the challenge."

In Queens, four tunnels totaling 3,050-m (10,000-ft) connecting the 63rd Street tunnel to existing LIRR lines will be completed by a pair of Herrenknecht slurry TBMs. When these machines are launched (expected to be later this year), they will be the first to use precast concrete segmental linings together with pressurized face TBM's in the New York area because of the soft ground conditions at that part of the project.

"We are using pretty much every technique there is in tunneling," Thompson said. "Once we begin tunneling in Queens, we will be using slurry machines for the first time in this area. We are already doing microtunneling with Herrenknecht microtunneling machines (on 1.5-m- or 5-ft- diameter utility tunnels). We are going to be doing shaft sinking with ground freezing and jet grouting (at the Sunnyside Yard in Queens). We will be doing sequential excavation when we do the Northern Boulevard. That's all soft ground and that will be associated with ground freezing. We have hard rock TBM's, we have drill-and-blast going and we have roadheaders going in the Grand Central Station cavern. And then we have all of the mechanical excavation going. From a tunneling point of view, we span the galaxy of techniques."

On the Queens side of the tunnel, there is another great challenge where the majority of the work will take place under, and within, the massive Sunnyside Yard where ESA work must be done around the current rail lines.

"The biggest challenge at the Sunnyside Yard will be negotiating the lines," said Horodniceanu. "The engineering above ground might not be the most complex but, to maintain traffic while we are doing it, is a very complex job."

The Sunnyside Yard and Harold Interlocking carry more than 700 LIRR and Amtrak trains per day. Ground conditions are expected to include glacial till with boulders and intact bedrock and the area includes limited service areas, contaminated plumes that cannot be moved, restricting permissible ground water draw down rates and the need to minimize disruption to the overlying railway.

"We started the excavation in the bell mouth to launch the two soft ground machines to go under the Sunnyside Yard," said Rhodes. "We will spread the tracks apart and then daylight the tunnels out so that, when the LIRR trains come down, they can hit a switch and come into the tunnels from west bound or out for east."

One of the last pieces on the project is the Northern Boulevard Crossing, a 36-m (120-ft) link that will connect the Manhattan tunnels to the Queens tunnels. Northern Boulevard is one of the busiest thoroughfairs in Queens with New York City Transit lines in a cut-and-cover box directly beneath an elevated railroad structure supported on piles above it. ESA is planning to construct a three-track tunnel beneath these structures using sequential excavation methods in conjunction with ground freezing.

Structural steel columns will support the Metro-North's upper level while the old columns (marked in pink paint) will be removed to make way for four escalator wellways under Grand Central Station. Photo by William Gleason.

MTA projects

The East Side Access project is one of five that is being, or has been, overseen by MTA Capital Construction.

The No. 7 Line Extension project recently celebrated completion of its first phase when the second of two TBM's broke through at the 34th Street Station cavern (See page 3). The New York City-funded $2.1-billion extension of the 7 Line is the first subway expansion in the city in decades and will help turn the Hudson Yards vicinity into a vibrant, 24-hour neighborhood, containing a mix of commercial, residential, retail, open space and recreational uses.

The full Second Avenue subway project will include a two-track line along Second Avenue from 125th Street to the Financial District in Lower Manhattan. It will also include a connection from Second Avenue through the 63rd Street tunnel to existing tracks for service to West Midtown and Brooklyn. Sixteen new Americans with Disabilities Act (ADA) accessible stations will be constructed.

The Second Avenue subway will reduce overcrowding and delays on the Lexington Avenue line, improving travel for both city and suburban commuters and provide better access to mass transit for residents of the far east side of Manhattan. Stations will have a combination of escalators, stairs and, in compliance with the ADA, elevator connections from street-level to station mezzanine and from mezzanine to platforms.

Under the current plan, the project will be built in four phases. Phase one will include tunnels from 105th Street and Second Avenue to 63rd Street with new stations along Second Avenue at 96th, 86th and 72nd streets and new entrances to the existing 63rd Street Station.

The first construction contract involves the construction of new tunnels between 92nd and 62nd streets, the excavation of the launch box for the TBM machine at just south of 92nd to 95th streets, and access shafts at 69th and 72nd streets. These shafts will be used for the subsequent construction of the 72nd Street station. Contract one is expected to take about 45 months to complete with tunneling scheduled to begin in the spring of 2010. Two other contracts are also under way – the contract to build part of the permanent structure and entrances for the new 96th Street Station and the contract to construct two open cut shafts north and south of the planned 86th Street Station.

MTA Capital Construction is building a new Fulton Street Transit Center at the corner of Fulton Street and Broadway, improving connections to six existing Lower Manhattan subway stations. The project will also improve connections to the No. 1 Line Cortland Street station at the World Trade Center site that will reopen based on the Port Authority's schedule. These improvements will improve travel for thousands of daily commuters and Lower Manhattan residents and visitors and better connect the subway with PATH service and the World Trade Center site.

The project includes the creation of a new Transit Center facility at the southeast corner of Fulton Street and Broadway, providing improved street level access and visibility.

MTA Capital Construction has built the new South Ferry Terminal Station for the No. 1 subway, which opened to customers in March 2009. The new station is located underneath Peter Minuit Plaza in Lower Manhattan, adjacent to Battery Park and the Staten Island ferry terminal.

The $530-million project corrects existing physical and operating deficiencies, which limited train capacity and reduced subway reliability for millions of customers each year. The new station reduces customer travel times, provides additional station entrances and ADA accessibility, and reduces noise as trains enter and leave the station. ■

FEATURE ARTICLE

Modeling helps tame surges in rapidly filling storage tunnels

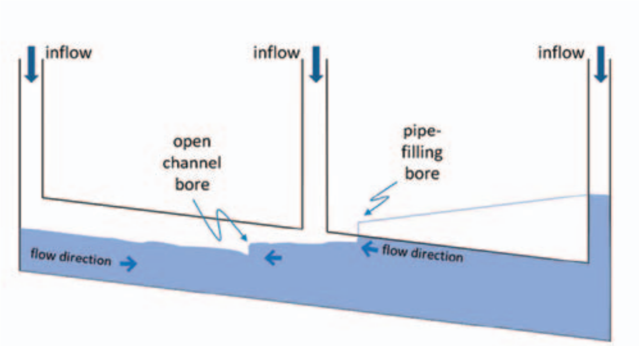
Deep tunnels have been used for decades for the temporary storage of large volumes of urban runoff, both storm water and combined sewer overflow (CSO). Tunnels are attractive because they reduce surface disruption and do double duty as storage and conveyance systems, collecting overflows from multiple locations and transporting them for treatment to various facilities. Like any hydraulic system, however, there are dynamic effects that must be fully understood during the design phase so that the final constructed product does not have unintended negative consequences. Preliminary sizing of storage tunnels is typically based on the total volume required. For example, if studies have determined that a volume of 56.8 ML (15 million gal) will provide the intended level of control, then that figure can be used, along with a preliminary idea of the desired tunnel length, to compute the required diameter. Of course, filling a long tube with water from various points along the way is not at all the same as pouring water into a bucket, and these dynamic effects require additional attention from design engineers.

The rapid filling of storage tunnels can lead to the formation of bores, which are essentially moving walls of water. An open channel bore can build in height until it reaches the crown of the tunnel, at which point it becomes a pipe-filling bore. Figure 1 depicts both kinds of bores moving upwards in a rapidly filling tunnel. Bores can strike the ends of tunnels with tremendous force, driving water and entrained air upwards into dropshafts and creating strong pressure surges in portions of the tunnel that are already filled. If the hydraulic surges are high enough to reach grade, they can cause overflows and/or damage structures at the surface.

Trapped air pockets can occur through several phenomena, including the reflection of bores off dropshaft structures and the occurrence of "premature pressurization." The latter refers to the situation where the inflow to a tunnel is increasing more rapidly than the tunnel can convey it, such that the pipe becomes surcharged at an upstream point while points downstream are still flowing as an open channel. These air pockets are a great nuisance as they migrate toward points in the tunnel where they can rise to the surface, which are often shafts that are already filled with water (Fig. 2). The "geyersing" that results can be hazardous and costly.

FIG. 1

Schematic depiction of bores in rapidly filling tunnels .



Peter Klaver

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Modeling approaches

The standard approach to hydraulic modeling of waste water and stormwater collection systems has evolved considerably in the last decade, to where sophisticated and powerful models can easily be built on a typical desktop computer. These models employ a "link-node" framework, in which (in the simplest of terms) the sewer pipes are the "links" and the manholes are the "nodes." A model simulation will produce a time history of flow in each link and water depth at each node. While these models are capable of realistically simulating a variety of real-world flow characteristics in sewer systems, including backwater effects, reversals, surcharging and even surface flooding, the link-node framework is unable to accurately simulate the issues associated with rapid filling for a number of reasons. The main issue is that the flow in a link is required to be constant from one end to the other. In rapid filling, however, there are dramatic differences in flow and depth occurring over relatively short distances. Further, link-node models represent pressure flow in a simplified way that neglects the compressibility of water and, thus, will not simulate pressure waves that arise from the sudden reversal of flow that occurs when a bore strikes a dropshaft. Lastly, link-node models handle the transition from gravity flow to pressure flow in an approximate fashion that is functional, but will not simulate subatmospheric pressures that result from surge waves.

A model for simulating surges in tunnels needs to overcome all of these limitations. The problem has been attacked from different angles by various researchers over the years, and there are adequate models available for certain limiting cases, such as a single pipe-filling bore. Hydraulic transients in fully pressurized systems can be simulated by an approach known as the method of characteristics (MOC), which has a long history of successful application to waterhammer analysis for pressurized water distribution systems. Although MOC alone will not handle the rapid filling problem, there is an approach known as "shock fitting" in which a pipe-filling bore is assumed to occur, and the movement of the bore is tracked through the conservation of mass, with MOC employed to calculate the surge effects. This approach has been used with some success. But the assumption of the pipe-filling bore must be robust, and that is not always the case. A different approach, known as "shock capturing," employs a numerical method to predict the actual of formation of bores, which may or may not reach the crown of the pipe, and then track their movement.

Recent research at the University of Michigan by Vasconelos and Wright (all citations) has produced a refined shock capturing model and validated it against extensive laboratory-scale physical hydraulic models. This more generalized model handles multiple bores, any of which can transition from open channel to pipe-filling and back again, as well as pressure waves resulting from reflection-induced flow reversals. The model also uses the novel approach of conceptually separating hydrostatic pressure, representing water depth in the tunnel, from the surcharge pressures that occur only in pressurized conditions. This idea, in

FIG. 2

Schematic depiction of air pocket movement.

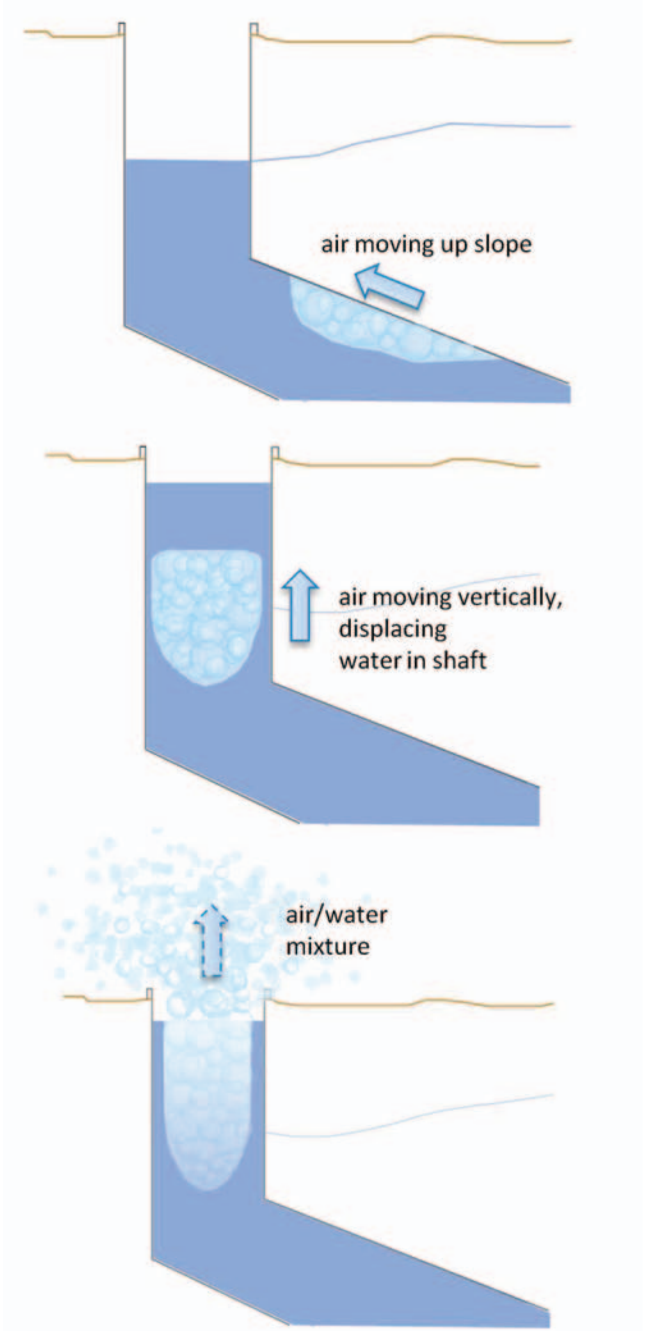


FIG. 3

Effects of bore reflection in drop structure.

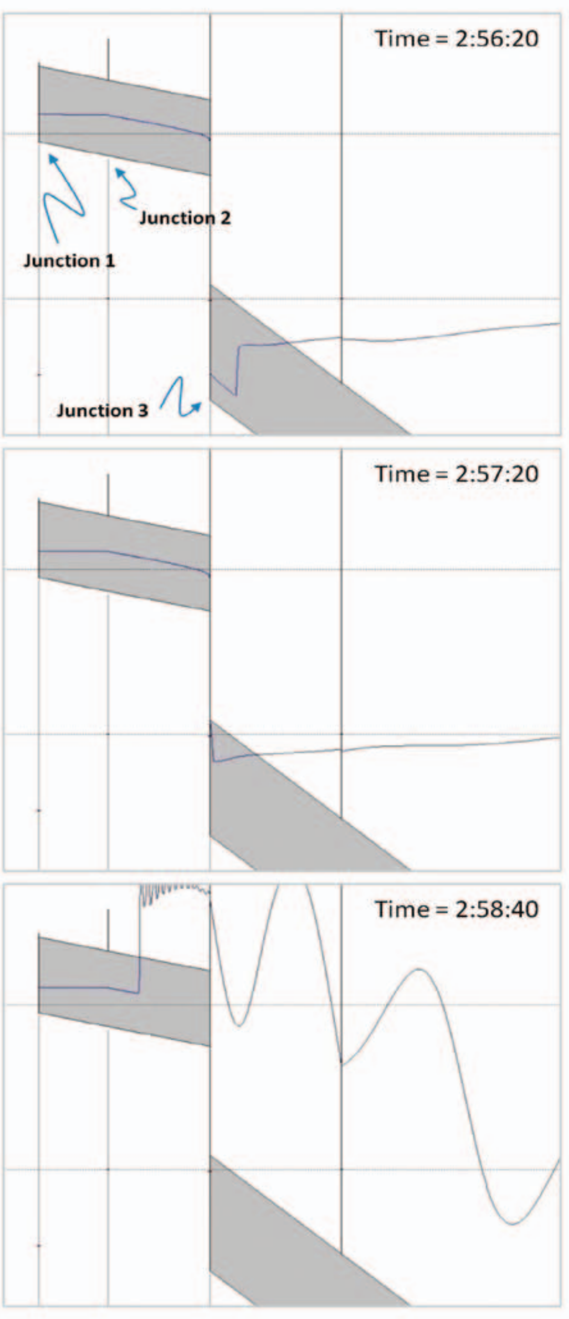
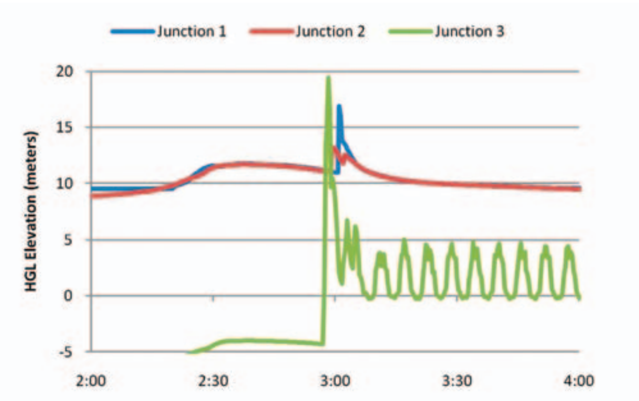


FIG. 4

Time series of HGLs corresponding to Fig. 3.



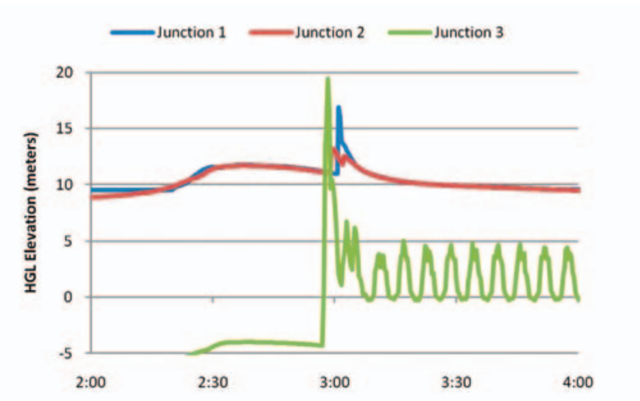
conjunction with the structural equivalence between unsteady incompressible flow equations in elastic pipes and unsteady open channel flow equations, allows the model to simulate both flow regimes using the same generalized set of equations, and readily model the transition from open channel flow to closed conduit flow. The model framework is documented in peer-reviewed publications. LimnoTech, in conjunction with University of Michigan scholars, has developed an implementation of the model called surge and hydraulic analysis for tunnels (SHAFT). The SHAFT model has been successfully applied to CSO storage tunnels that are currently under design in Washington, D.C. and London, England, with other applications to follow. SHAFT helped identify potential surge issues in both tunnel systems and was used to evaluate design changes to reduce the impact of surges.

Applications

SHAFT has been applied to several large combined sewer tunnel storage projects that are currently under design; two project owners discussed in this article are the District of Columbia Water and Sewer Authority (DCWASA) in Washington D.C., and Thames Water (TW) in London, England. The model's flexibility was put to the test in these early stages when ongoing subsurface exploration can lead to frequent changes in alignment and geometry. SHAFT could identify general surge issues arising from a variety of tunnel configurations and, as the alignments became finalized, the model was also used to examine details such as venting and offline storage locations.

FIG. 5

Effect of steep tunnel slope on bore propagation.



District of Columbia

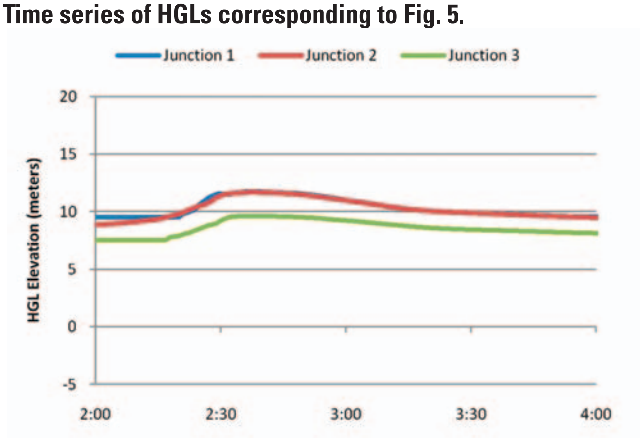
The DCWASA long-term control plan (2002) includes a range of controls that are designed to capture, on average, more than 7.6 GL/a (2 billion gal/year) of CSO that would otherwise overflow to receiving waters that include the Potomac and Anacostia rivers and Rock Creek. The centerpiece of the controls is a system of three tunnels that, when completed, will stretch nearly 17 km (10.5 miles) and provide more than 719 ML (190 million gal) of storage. The Anacostia River Tunnel (ART) will follow a route near the river and collect CSO from several outfalls along the way. At Poplar Point, it will connect to the Blue Plains Tunnel (BPT), which will convey the wastewater the rest of the way to the Blue Plains Wastewater Treatment Plant on the Potomac River. The ART and BPT will be constructed in the first phase and, together, will consist of nearly 11 km (7 miles) of 7-m- (23-ft-) diameter tunnel at depths ranging from 25 to 36 m (82 to 118 ft) below grade. The Northeast Boundary Tunnel (NEBT) will be built in a second phase, adding another 4.6 km (2.8 miles) of 7-m (23-ft-) diameter tunnel, along with 4.7 km (2.8 miles) of 4.6-m- (15-ft-) diameter tunnel and nearly 4 km (2.5 miles) of 3.7-m- (12-ft-) diameter tunnel.

SHAFT was used to simulate a large number of different tunnel configurations during the preliminary design process. The conditions simulated could be varied in three essentially independent ways: tunnel layout/geometry, filling scenario and river surface elevation. The different layouts were provided by the tunnel design team, whereas the different filling scenarios came from a link-node model of the DCWASA collection system that was subjected to different rainfall events. Some filling scenarios began with an empty tunnel and others with the tunnel partially full to simulate back-to-back events. Lastly, different water surface elevations in the Potomac and Anacostia rivers simulated the effects of unusually high tides on the outflow characteristics of the tunnel.

Simulations focused on two different storm events — the 15-year, six-hour storm and the 100-year, six-hour storm. The 15-year storm was of interest because of a requirement to control flooding in the northeast boundary area up to this particular level. The 100-year storm represented a sort of worst-case scenario, motivated by the idea that the storage tunnels should "do no harm." While the system will clearly overflow in this case, it is still important to prevent surge-related damage to structures, geysers due to the presence of air pockets and the like. Not surprisingly, the 100-year storm produced the most dramatic surge-related effects, which led to several design modifications intended to mitigate them.

FIG. 6

Time series of HGLs corresponding to Fig. 5.



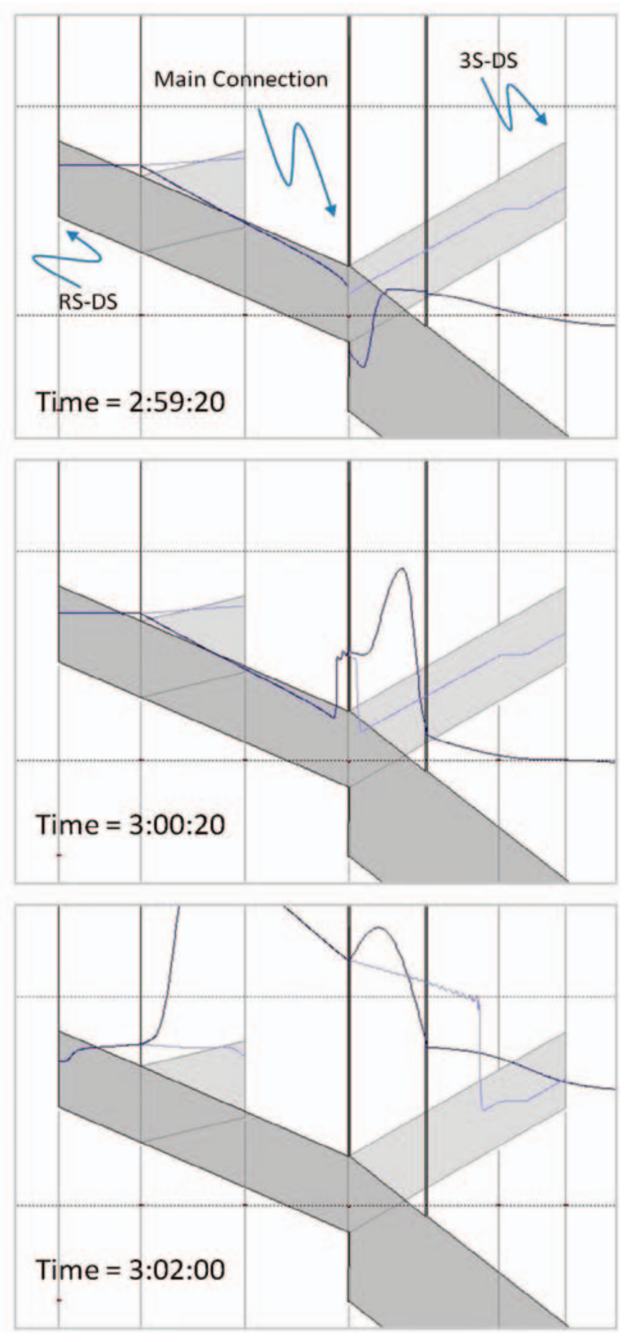
An early alignment had a portion of the NEBT at a slope of 0.46 percent, leading to a shaft with a 13.6-m (44.6-ft) vertical drop. Upstream of this drop shaft the tunnel diameter is reduced to 4.6 m (15-ft). SHAFT simulations using the 100-year storm showed a large open channel bore striking this shaft and resulting in a large spike in HGL. Figure 3 shows three snapshots of the water surface elevation in the tunnel, and Fig. 4 shows a time series of the HGL at the drop shaft and two other shafts at upstream locations. In the first panel of Fig. 3 (in which the vertical scale is exaggerated), the bore is closing in on the drop shaft. In the second panel, 60 seconds later, the bore has reflected and an air pocket is trapped. In the final panel, there is now a pipe-filling bore in the smaller-diameter tunnel, along with large oscillations in pressure in the main tunnel.

Ongoing geotechnical investigations suggested that a steeper slope had advantages in terms of constructability and SHAFT demonstrated that this configuration had advantages in terms of surge control as well. Figure 5 shows the alternate arrangement, in which the 7-m- (23-ft-) diameter tunnel is at a slope of 0.83 percent and meets the smaller diameter portion of the tunnel invert-to-invert. The three panels, representing the same moments of the scenario as shown in Fig. 3, show how the steeper slope has taken a great deal of momentum out of the bore, such that it fails to strike the shaft; no air pocket is formed, either. Figure 6 shows that the HGLs no longer have the spikes associated with surge propagation. While it is important to note that constructability was the chief driver behind this design change, SHAFT demonstrated that the steeper slope had other advantages as well.

The next results shown here are from a later stage in the design, in which the same location of the NEBT has now become a three-way junction with multiple smaller-diameter branches. An economic analysis suggested that the upper branches could have a diameter of 3.7 m (12 ft), instead of the original diameter of 4.6 m (15 ft), and that the tunnels would just surcharge at the design inflow rates for the 100-year storm. While this approach is often acceptable, SHAFT was used to investigate whether the surcharge

FIG. 7

Propagation of bores in surcharged tunnel.



condition would pose surge-related difficulties. Figures 7 and 8 illustrate the story. Other changes to system volume and inflow rates meant that the bore now completely reaches this location and it is seen that pipe-filling bores are created in the branch tunnels. The HGLs in Fig. 8 show the effect of the bore initially striking the upstream end (RS-DS), as well as the later impact at 3S-DS and the resulting reflections. Note that peak HGLs at all of these locations exceed 10 m

FIG. 8

Time series of HGLs corresponding to Fig. 7.

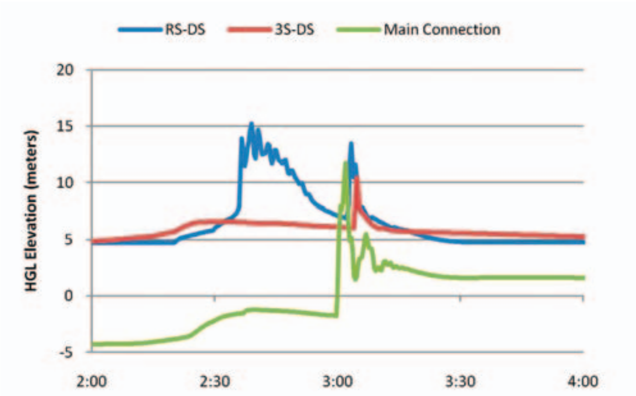
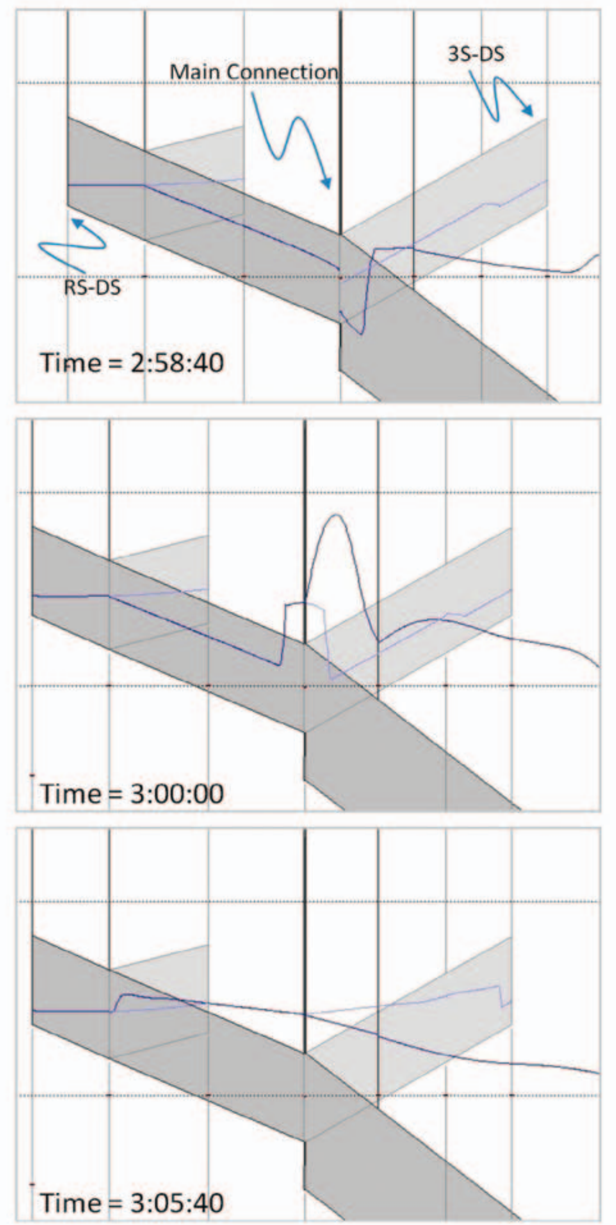


FIG. 9

Propagation of bores in non-surcharged tunnel.



(33 ft), which is well above grade and would lead to surface flooding and/or structure damage.

Restoring the branch tunnels to their original diameter of 4.6 m (15 ft) not only provides additional storage volume but also changes the effect of the bore propagation in the most upstream reaches. SHAFT results for this configuration are shown in Figs. 9 and 10. The pipe-filling bore in the large tunnel translates into two such bores in the branches (second panel). But the additional volume in the branches allows these bores to transition to open channel bores and they eventually run themselves down before causing excessive surge pressures. As Fig. 10 indicates, there are moderate spikes at the upstream ends of the branches but peak HGLs barely reach 6 m (20 ft), which is below the critical elevation at these locations. Incidentally, this simulation is a good example of how a shock capturing model can simulate the formation and degradation of bores, as opposed to the shock fitting models that assume a pipe filling bore is present continually.

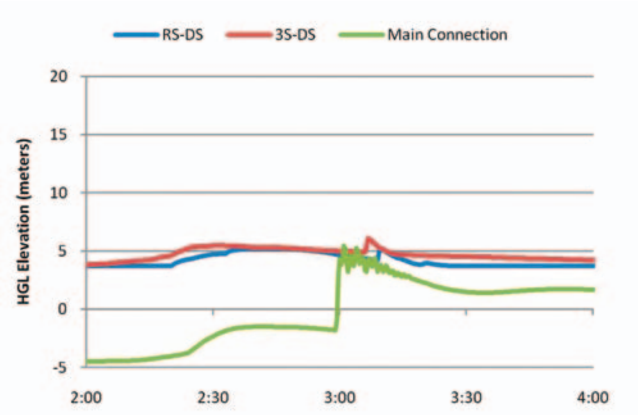
Thames Tideway

The Thames Tideway project, in London, England, consists of deep tunnels that, like the DCWASA tunnels, will store and convey large quantities of CSO for subsequent treatment. The London tunnels will also be constructed in phases, with the first phase (the Lee Tunnel) being completed by 2015 and the second phase (the Thames Tunnel) targeted for completion by 2020. The objective of these tunnels is to reduce the frequency and volume of CSO into the tidal River Thames and its tributaries within greater London. SHAFT modeling is being conducted to ensure that the Lee and Thames Tunnels will not experience excessive HGLs that cause flooding to grade or backups in the existing collection system, to predict venting rates at relief points and to identify locations where trapped air pockets may develop.

The London Tideway tunnels (LTT) system will consist of about 29 km (18 miles) of 7.2 m (24 ft) main tunnel and 9 km (5.6 miles) of connection tunnels ranging in size from 2.2 m to 4.5 m (7.2 to 14.7 ft). They will be constructed in conjunction with significant capacity expansions of two major treatment works. With a total storage volume of nearly 1.15 Mm^3 (40.6 million cu ft), the completed system will capture about 96 percent of the typical year CSO volume and reduce spills to fewer than four events per year. Analysis of tunnel performance has focused on inflows produced from rainfall corresponding to a 15-year, two-hour event, which, when applied to the entire catchment area at the same time, was equivalent to a 50-year event at a more local scale. These simulated flows include both pump station output as well as flows routed to the tunnels by collection tunnels and CSO

FIG. 10

Time series of HGLs corresponding to Fig. 9.



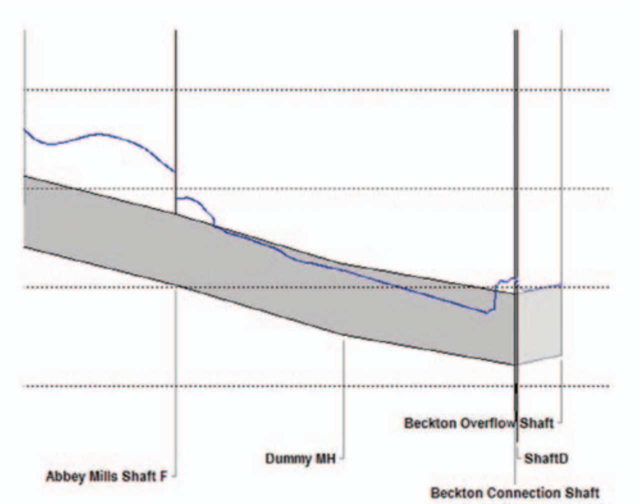
consolidation structures. As much of the existing collection system is capacity-limited, larger events are not expected to deliver significantly greater peak flows to the tunnels.

Inflow hydrographs came from a link-node model of the existing London collection system, which included the tunnel system so that some interaction between it and the existing system could be simulated. This approached aided in the evaluation of real-time controls for limiting inflow to the tunnel, which became more important after the initial SHAFT simulations, as discussed later. Flows were delivered to the tunnel through more than 20 inlets, the exact number depending on the arrangement of tunnel geometry under each scenario. Flap gate closure was also simulated based on simulated water levels in drop shafts rising above collection basin elevations.

The SHAFT model identified issues with the various tunnel geometry arrangements during the 15-year storm event, including premature pressurization and excessively high HGLs at locations along the Thames, generally around the farthest upstream reaches of the tunnel. An example of premature pressurization is shown in Fig. 11, which focuses on a large air pocket that has formed at the lower end of the tunnel due to surcharge conditions near Abbey Mills Shaft F. As noted previously, premature pressurization is essentially a result of "too much, too soon," so mitigation efforts looked at limiting the total inflow to the tunnel. The peak composite inflow rate (that is, all sources added together) for the 15-year event was nearly 390 m^3/s (143 cu in./min), compared with 290 m^3/s (106 cu in./min) for the two-year event, which did not result in premature pressurization. Based on this comparison, it was proposed to determine caps on inflow rates at key locations, such that the peak composite inflow rate would not exceed 290 m^3/s (106 cu in./min). After various trials, workable solutions were found, including the scenario shown in Fig. 12. This pipe-filling bore, while still a force to be reckoned with, is nowhere near the problem posed by the 4-km- (2.5-mile-) long air pocket seen in Fig. 11. Limiting the inflows makes better use of the tunnel volume by avoiding flooding to grade from surge-induced wide variation in HGLs, as well

FIG. 11

Example of premature pressurization showing air pocket.



as preventing geysers caused by air pocket exhaustion. In practice, the inflow caps determined in the modeling do not have to be absolute at every location. When rain is more localized, individual inflow locations could exceed the caps as long as other locations are not filling, or filling at reduced rates. The challenge for real-time control is to keep an eye on the total inflow rate to the system.

A re-evaluation of real-time inflow controls produced a filling scenario without premature pressurization. But there were still high HGLs at the upstream end of the tunnel system to contend with. Various construction constraints at the surface meant that HGLs more than a few meters above grade could not be tolerated. For modeling purposes, an elevation of 2 m (6.5 ft) was considered the absolute maximum at these locations. Figure 13 shows time series at certain potentially problematic locations, from a SHAFT simulation in which HGLs were allowed to rise as high as

FIG. 12

Premature pressurization avoided through inflow controls.

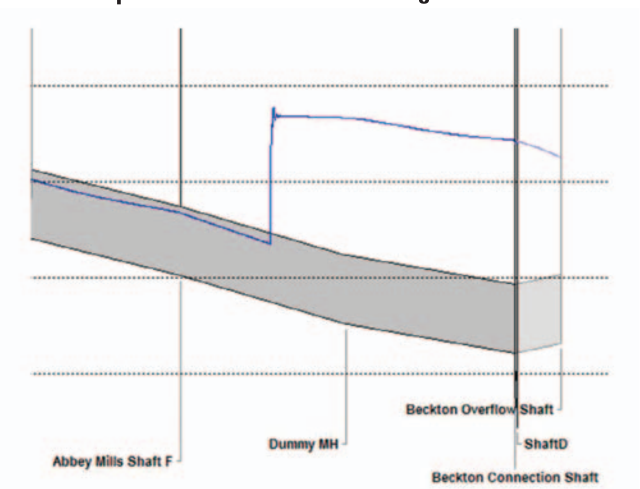


FIG. 13

HGL time series showing bore impact and subsequent reflections.

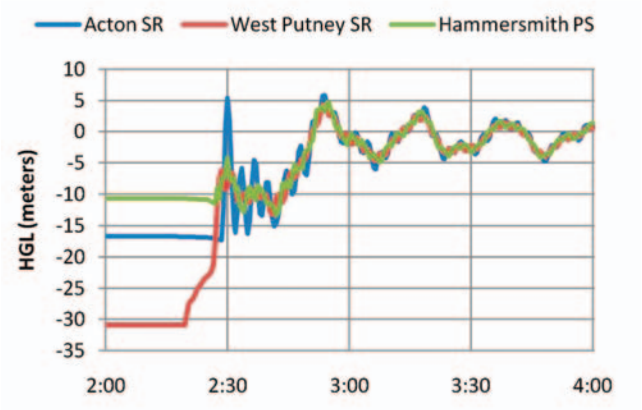
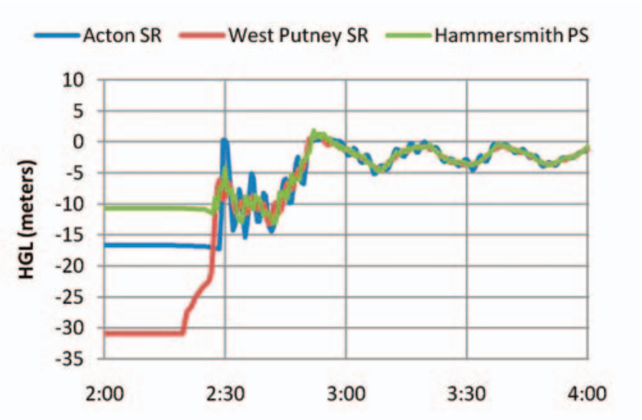


FIG. 14

HGL time series showing attenuation of impact and reflections.



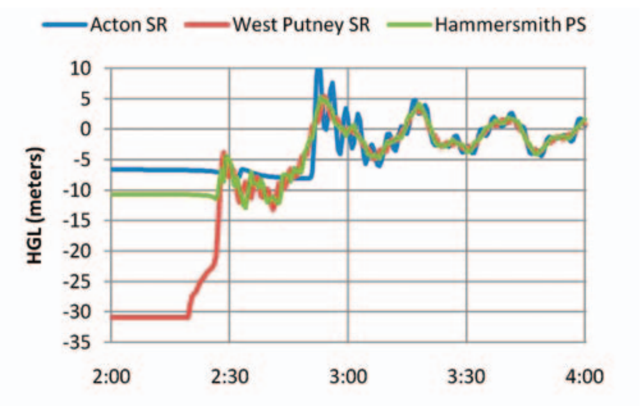
momentum would allow. The Acton Storm Relief junction represents the furthest upstream point in the tunnel, and is actually at the end of a 2.2-m- (7.2-ft-) diameter tunnel that is elevated relative to the main 7.2-m- (23.6-ft-) diameter tunnel. The spike at 2:30 represents the bore striking this upstream point, with the subsequent surges due to reflections of this pressure wave off other structures — essentially the entire tunnel contents are sloshing back and forth after filling.

The initial approach to mitigating these peak HGLs was to place overflow relief points at the locations experiencing the highest HGLs and to determine two things: whether overflow relief would be enough to attenuate excessive HGLs at other locations, and just how much water would spill from these points. Figure 14 shows the result of this model run, in which five relief points were modeled by adding overflow weirs at an elevation of zero meters. The locations shown in the figure represent the highest peaks in the entire system and none was above 1.8 m (5.9 ft). The total volume spilled in this scenario was nearly 6,400 m3 (226,000 cu ft), however, which is not a trivial volume to contain at the surface, at least not in the densely populated London area. Subsequent simulations involved placing overflow points at different locations and upsizing the smaller branch tunnel to Acton. It was found that by increasing the diameter of the Acton spur to 4.5 m (14.7 ft) (noting that this diameter was in use at other locations) and consolidating the storage to two locations, similarly acceptable peak HGLs could be achieved with a total overflow volume of only 620 m^3 (21,900 cu ft).

Figure 15 shows the results of another run in which the Acton spur was raised another 10 m (33 ft) relative to the main tunnel, so that the initial bore would reflect off the dropshaft instead of making its way into the spur. No overflow relief points were included in this run, so its results could be directly compared with the results shown in Fig. 13. While raising the Acton spur does indeed remove that first spike seen at 2:30, there is still a major surge that reflects through the system and leads to excessive peak HGLs at the other locations. In fact, the initial HGL spikes at Acton are even higher than when the spur tunnel was at its original elevation. As it turned out, raising the spur was not viable from a construction standpoint. But the simulation shows how SHAFT can facilitate analysis of novel solutions.

FIG. 15

HGL time series showing reduced initial bore reflection with high surges.



Conclusions

SHAFT is a very useful computational tool to evaluate alternatives for mitigating surges and trapped air in large diameter tunnel systems. SHAFT's innovative computational approach for simulating open channel and pipe-filling bores, hydraulic transients and location of trapped air pockets helps users to quickly determine potential problem areas in proposed or existing tunnel systems and to assess solutions. Every step of the way, the simulations for the DCWASA and London Tideway Tunnels systems have provided designers with peak HGLs, peak venting rates and locations of large air pockets. Further, the tunnel designs have been adapted to minimize the effects of surges and trapped air to reduce the risk of failure under extreme filling and increase everyone's confidence that expensive retrofit solutions will be avoided. (References available from the author.) ■

FEATURE ARTICLE

Challenges of a busy industry; shaft construction discussed at Fox Conference

An unprecedented amount of tunneling and underground construction work in the New York region has also given rise to an unprecedented number of challenges. From finding qualified people to work on massive infrastructure projects that transform transportation of people, utilities and water and waste beneath the city, to working around existing infrastructure including long-ago buried tunnels and utilities that no one bothered to put on a map, tunneling and underground construction in the New York region is full of unique obstacles. At the UCA of SME's annual George A. Fox Conference at the Graduate Center, City University of New York, a record crowd of 345 industry professionals gathered to learn about the challenges of working in New York and beyond.

Michael Horodniceanu, president of New York's Metropolitan Transportation Authority (MTA) Capital Construction, spoke of the challenges the industry faces during his keynote address.

MTA Capital Construction is responsible for the largest transit expansion program in several generations through five area projects: the Fulton Street Transit Center, the South Ferry Terminal, the East Side Access project, the Second Avenue Subway line and the No. 7 Line extension. MTA Capital Construction is currently running projects worth more than $15 billion.

Along with the obvious challenges that come from boring through schist and granite while being sure not to disturb the buildings above or subway and water tunnels buried below, Horodniceanu said the thriving industry faces challenges of experience, geotechnical issues, utilities, working in a dense urban areas and community impacts.

"As a client, we have lost a lot of the experienced people and the knowledge we once had. In the last 20 years, we have had little experience building tunnels, as such, we have lost our historical knowledge," Horodniceanu said. "Now there is a lot of competition for workers. Just in our region, there are 13 tunnel boring machines (TBM) that will soon be running (MTA System expansion seven; DEP Water tunnel one; NJ Mass Transit Tunnel four and DEP Siphon project one) and there are major projects in London, Instanbul and Hong Kong that will compete for resources. And, we have learned that we are not an easy client to work with, so we have found a limited pool of contractors. We are lucky to get two or three bids for some jobs."

From the top-level executives overseeing a multimillion dollar project, to the entry-level laborer, it is getting increasingly difficult to find people to work on the many projects in the area. Membership in the local union, 147, for New York's urban miners, the Sandhogs, has expanded during the past two years from hundreds of members to more than a thousand. But workers are still in short supply.

Michael Horodniceanu, president of MTA Capital Construction, spoke about the challenges of working in New York during his keynote address to 345 attendees.

And it's a problem without an easy solution in sight. In addition to the projects already under way, there are more big ones, including the Mass Transit Tunnel that will link New Jersey to New York with a tunnel under the Hudson River that will compete for people.

And, of course, there are the issues that come with working in a city as dense as New York. For each project, the right method must first be chosen. The East Side Access, for instance, is using everything from hardrock tunnel boring machines to drill-and-blast methods while the Second Avenue Subway project is using TBM's and has used cut-and-cover methods. And, in Queens, soft ground conditions will a require a different kind of TBM suited for that kind of ground.

While these machines bore through the ground, it is not uncommon to find buried utilities or archeological finds that can bring a TBM, and a project to a halt while they are identified.

And to do all of this in the dense area of the city is a challenge in and of itself.

"When you work in the city, you must make sure to remember that you are working in a community," Horodniceanu said. "You need to keep your project clean, be aware of noise and vibration.

"The moral of the story," said Horodniceanu, "if you want to work here, you have to plan well in advance. You really have to acknowledge the issues and look at them at very carefully. And that also calls to us as a client to

William Gleason,
Senior Editor

be realistic. We tend to be very optimistic when we ask for something to be done."

Tunnel shaft construction

An issue that is not unique to the New York region is that of tunnel shaft construction. It was the theme of the 2010 conference. From the construction of the Lake Mead Intake No. 3 Access Shaft and Offshore River Shaft in Nevada to the excavation of the Ballinger Freeze Shaft in Seattle, WA, tunnel shaft construction was discussed through the afternoon session of the conference.

Lake Mead is the source of water for millions of people in the southwestern United States.

Created by the construction of the Hoover Dam on the Colorado River in 1935, the lake is the largest man-made reservoir in the United States at 177-km (110-miles). A prolonged drought is straining the system and the lake level has fallen by 31 m (100 ft) in the last eight years. One of two intakes that currently draw water from the lake could be rendered unusable if the lake level continues to fall.

To combat this, a new intake will be placed on the lakebed, 100 m (328 ft) below the surface from an onshore access shaft dug to a depth of 200 m (656 ft).

To get to the 6-m- (20-ft-) diameter, 4,660-m- (15,300-ft-) long tunnel bored by a high water pressure, dual mode Herrenknecht, a 182-m (600-ft) hardrock shaft first had to be sunk.

Jon Hurt, associate principal with Arup and Jim McDonald of S.A. Healey Co., shared some of the challenges faced with this project.

At the Western Regional Conveyance project in Boone County, KY five excavation methods (backhoe, drill-and-blast, raise bore, auger drilling and roadheader) are being used to sink five shafts on the $230-million project that broke ground in 2009.

Lawrence Lenahan, vice president with McNally Tunneling Corp. in Cleveland, OH, spoke about the various methods that will support 9,900 m (32,500 l ft) of rock tunnel at the project shafts that range in depth from 16 m (55 ft) to 88 m (290 ft). Included are one vortex drop shaft and one flow control gate shaft.

A record 345 industry professionals attended the George A. Fox Conference in New York.

TBM portal at the Western Regional Conveyance Tunnel in Kentucky. The project was one of many discussed.

At the time of the conference, excavation of Shaft 5 and Shaft 4 was completed and nearly completed on Shaft 2. Excavation on shafts 3 and 1 had not yet begun. Tunnel excavation through Shaft 4 was about 20 percent completed.

When completed, the Western Regional Conveyance Tunnel will include 914 linear m (3,000 linear ft) of 2.6-m (8.5-ft) diameter pipe installed by open cut. The project will include a 123-m (700-ft) aerial bridge for a 2.6-m (8.5-ft) diameter pipe.

Other shaft construction discussed included work on the Manhattan Shafts for the NYC Water Tunnel; and the building of the circular cofferdam for ventilation building No. 6 at the Ted Williams Tunnel in Boston, MA.

Verya Nasri and Anil Parikh discussed the construction of the Second Avenue caverns and Pat Rooney gave a presentation on the Croton Water Treatment plant tunnels.

In another sign of how vibrant the industry is, Mike McHugh, vice president with Moretrench American Corp. gave his review of hometown projects in which he brought the crowd up to speed on the Second Avenue Subway project; the Fall River CSO project in Fall River, MA; the South Cobb Tunnel in Atlanta, GA; East Side Access; No. 7 Line Extension; the North Shore Connector, Pittsburgh, PA; Edison Force Main Tunnel project, Sayreville, NJ; the New Croton Aqueduct Rehabilitation project in Bronx, NY; Hudson River Falls GE, Hudson Falls, NY; NBC Tunnel and Pump Station, Snellville, GA; South River Tunnel and Pump Station, Atlanta, GA; City Water Tunnel No. 3, NY; Harbor Siphons tunnel, NY; WASA CSO tunnels, Washington, D.C.; Atlanta North South tunnel, Atlanta, GA; Midtown Tunnel, Newport News, VA and the Mass Transit Tunnel from New Jersey to New York.

Paul Beljan spoke about the Harlem River Utility Tunnel and Walter Kaeck closed the one-day conference with a presentation about shaft construction methods and potential problems.

The George A. Fox Conference will return to the Graduate Center, City University of New York on Jan. 25, 2011. ■

FEATURE ARTICLE

No. 7 subway line project advances with Atlas Copco rigs and tools

An Atlas Copco E2C boomer drills at bench at the No. 7 line extension project in New York.

Soon New York City will have a new train station. A tunnel project is under construction to extend Line 7 to a new station that is located near the Jacob K. Javits Convention Center. This is also part of the Hudson Yards redevelopment project that is intended to aid redevelopment of the west side of Midtown Manhattan around the Long Island Railroad's Caemmerer Railyard. The station, or "cavern" as it's called by those excavating it, will be the portal for that growth.

In the city, public transportation means high-rise residential properties will have better access to the business district, and those outside the area will have greater access to event facilities – two factors that are critical for development investment.

The $1.2-billion project is a joint venture involving three construction giants: J.F. Shea Co. Inc., Skanska USA Civil and Schiavone Construction. Together, they make up the general contracting entity called S3-II Tunnel Constructors, J.V.

The project consists of 1,830 m (6,000 ft) of double-tube tunneling and 365 m (1,200 ft) of cavern, which will be the future station at 11th Avenue and 34th Street. The project started in January 2008 with the cavern completion scheduled for late 2010. Tunnel boring machines are 6.8 m (22.6 ft) in diameter and will complete their portion of the work spring, 2010. The drill-and-blast cavern will be completed later in 2009.

When completed, the cavern will be 16.7-m- (55-ft-) high by 20-m- (65-ft-) wide. Excavation began by sinking a 12- x 14-m (40- x 45-ft) shaft to the cavern level. In total, two shafts will be sunk in the cavern. The project's equipment superintendent Kelvin Sampson said, "The boomer spent as much time in the air as it did drilling when the project began." The shaft was drilled and blasted vertically using ROC D3 crawler drills. Once a 30-m (100-ft) depth was reached – 9 m (30 ft) of overburden and 21 m (70 ft) of rock – the cavern excavation began.

Scott Ellenbecker

Scott Ellenbecker is editor-in-chief of Atlas Copco's Deep Hole Driller and Mining & Construction USA, Garland, TX, e-mail scott@drillstories.com.

Face drilling on the project is done during two shifts with two drillers on each drill. The Atlas Copco Boomer E2C 18, with computerized drilling function from Rig Control System, was modified for speed with two control panels. The drill is also performing a dual function of drilling for blasting and bolting. It is also outfitted with a man-basket for the overhead bolting work.

"The working head of the cavern is being drilled in three facings," said driller Jim Lawson. The center section works 9 m (30 ft) ahead of the two sides. All hole patterns and depths are preplanned and displayed on the screen. Once the driller moves his boom into place, an "X" on the screen shows the driller where to place the 47.62 mm (1.875 in.) bit as well as a leveling function for a straight hole.

Lawson commented that the drilling is efficient and that having consolidated rock makes the drilling easier. "The drill automatically drills the hole once I set it up on the hole – slower at first to collar the hole then speeding up as it goes. Each hole takes less than two minutes," said Lawson.

"This drill is all about working smarter, not harder – it does it all," commented Lawson.

Lawson also said the rig's automated drilling function keeps him from getting stuck. "It was tough trusting the drill to do the work, but after a few weeks, I was comfortable with it. It is really nice if you run into a void or shale – with the rig's anti-jamming feature, this drill does not get stuck," said Lawson.

Surface drilling underground

In addition to the Boomer E2C 18 working on the job, Atlas Copco also supplied two ROC D3 crawler drills to the project. The horizontal drilling work was performed by the E2C, but the ROC D3 was critical for the vertical work and sinking shafts.

The use of the ROC drills allowed for floor, ramp and shaft work to be performed while the boomer worked in other areas. "Those [ROC] D3's can go anywhere and climb any incline (encountered on site)," said Lawson.

A mucking shaft was excavated at the far end of the cavern to support the material removal. Uncommon to surface rigs, the ROC D3 was outfitted with lifting rings, so it could be efficiently raised and lowered in the shaft.

The Atlas Copco store in Clark Summit, PA also supplied a service technician for each shift. "We work really well with the contractor's service and maintenance crews, making sure all maintenance work is done right and on schedule," said Jim Mattila, one of Atlas Copco's service techs on site. The other two techs are Charlie Smith and Ed Cassidy.

Mattila commented that this crew was working at such a fast pace they did not want any breakdowns. "If there are any issues, we are here to help out and I'm hustling all day," he said.

The project called for a total of 114,700 m^3 (150,000 cu yd) of excavated rock. General superintendent Mike Jennings said that, in the three-shift operation, all shotcrete work is done on the day shift and all blasting is done on the second shift.

The new station for the No. 7 line expansion is taking shape.

When bolting, an average of 25 bolts are required for the center face. The roof requires resin bolts while side benches have Super Swellex. "We wanted Swellex everywhere, but we are following the engineered specifications," said Brian Jepsen, the site manager on the project.

An Atlas Copco boom rig at work.

Overall, the drillers and management have been happy with the success of Atlas Copco's equipment. Jennings said, "I have been very pleased at the smooth operation of the rigs and service from Atlas Copco. We had not used such high-tech rigs in the past, and everyone took to them well." He added that the round-the-clock service from Clark Summit and a 36-hour parts guarantee also made him rest a bit easier.

For drillers like Lawson, it's about seeing results. "Everyday I get something tangible from what I'm doing. I had a sales job before this, but this job allows you to see what you've done – and get paid for what you've done – and the next day everything changes. Now these drills – I could sell these drills. I could really sell something I believe in," he said. ■

World Tunnel Congress returns to Canada

For the first time since 1996, the World Tunnel Congress will return to North America when the World Tunnel Congress and 36th General Assembly will take place in Vancouver, May 14-20.

As the official representative to the International Tunnelling Association (ITA), the UCA of SME will be in attendance for the congress that will be held under the theme "Tunnel Vision Towards 2020."

This year's congress will focus on recent major developments in tunneling research, design, management and construction. More than 1,000 international industry professionals, including contractors, designers, manufacturers and government representatives are expected to attend the congress.

The technical program committee, comprised of industry leaders, practitioners and researchers from Canada, is planning various functions such as training sessions, keynote addresses by industry leaders, technical presentations and an exhibition. Although the focus will be on tunneling, the congress will also address relevant topics in the fields of mining, contracting practice, current standards and technology.

Jeff Hewitt, senior vice president, engineering, Canada Line Rapid Transit Inc., is scheduled to give a keynote presentation on the Canada Line Transit Project that was built ahead of the 2010 Olympic Games to connect Vancouver with Central Richmond and the Vancouver airport by a 19-km- (12-mile-) transit system. The line opened Aug. 17, 2009, 15 weeks ahead of the originally scheduled opening. The Canada Line began with an average of 83,000 passengers per day in its first six weeks and ridership has trended upward since then. By December 2009, the average daily ridership (including weekends) was 93,000 and the line had occasionally exceeded 100,000, three years ahead of expectations. The new service is expected to experience 142,000 boardings per day by 2021.

Susan Reed Tanaka, manager, engineering department, Toronto Transit Commission, has been invited to give a keynote presentation on "Tunneling Plans for Transit Expansion in Toronto."

The congress will also feature a robust exhibit floor with some of the latest products in the industry on display.

For more information about the ITA-AITES World Tunnel Congress and 36th General Assembly, visit the website at www.wtc2010.org. ■

Technical topics

- Innovative techniques and advances in geotechnical investigations for tunnel projects
- Tunneling in soft ground
- Hard rock tunneling
- Tunneling in weak rock
- Tunneling under high stress conditions
- New advances and innovation in mechanized tunneling
- Tunnelling under sensitive structures
- Geotechnical instrumentation and monitoring
- The use of underground space
- Rehabilitation and repair
- Risk assessments
- New advances in contract practices and procurement
- Commercial aspects for tunnel projects
- Tunnel lining and grouting
- Innovation and research for tunneling
- Sequential excavation and sprayed concrete linings
- Safety in tunneling

NAT to offer informative, entertaining agenda

The biannual North American Tunneling Confernece will be held in Portland, OR on June 20-23 under the banner "Tunneling, sustainable infrastructure."

With a full slate of technical sessions, sold-out exhibit floor and exciting field trips planned to the East Side CSO tunnel project in Portland and to the Portland Area WPA tunnel tour, this year's NAT Conference is sure to be informative and entertaining.

The conference will take place at the Marriott Downtown Waterfront Hotel. Workshops and short courses begin on Sunday, June 20 with technical sessions and the exhibit hall opening on Monday, June 21. Workshops include:

- Better specifications for underground projects - perspectives of owners, engineers, contractors and suppliers.
- Professional liability issues for consulting engineers on tunneling projects — perspectives of owners, engineers, contractors and suppliers.
- Grouting in underground construction.
- Shaft and tunnel blasting.
- Soft ground tunneling.
- Shaft design and construction.

Richard S. Staples, president of the Tunneling Association of Canada, will give the keynote address at the NAT luncheon on Monday, June 21. He will speak about tunneling in Canada, its past, present and future. Scott Burns will present a speech about the relationship between geology, soil and some of the world's finest wines that are produced in the Portland area at the awards banquet.

For more information, visit www.smenet.org/meetings. ■

TUNNEL NAME	OWNER	LOCATION	STATE	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	RFQ 1st Q 2010
Palisades Tunnel	NJ Transit Board THE Program	Newark	NJ	Subway	5,400 x 2	24.5	2009	S3 JV low bidder
Manhattan Tunnel	NJ Transit Board THE Program	New York	NY	Subway	6,000 x 2	24.5	2009	Awarded Barnard/ Judlau
THE 34th St. Cavern & Station	NJ Transit Board THE Program	New York	NY	Subway	2,200	100 x 100	2010	Under design
Second Ave. Subway Tunnels	NYC-MTA	New York	NY	Subway	2,200	30,000	2014	Under design
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	2010	Bid date 03/11/2010
Cross Harbor Freight Tunnel	NYC Regional Development Auth.	New York	NY	Highway	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	3-6	2011	Preliminary design
East-West Subway Extension	Baltimore MTA	Baltimore	MD	Subway	32,000	18	2012	Under design
WASA CSO Program Blue Plains tunnel Anacosita River tunnel Northeast Branch tunnel Northeast Boundry tunnel	DC Water and Sewer Authority	Washington	DC	CSO CSO CSO CSO	23,400 12,500 11,300 17,500	23 23 15 23	2011 2013 2018 2021	RFQ 1Q 2010 Under design Under design Under design
Market St. Drainage Improvements	City of Charleston	Charleston	SC	Sewer	3,000	10	2010	Under design
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	Funding secured
Lockbourne Interceptor Sys. Tunnel	City of Columbus	Columbus	OH	Sewer	10,000	12	2012	Under design
OSIS Aug. & Relief Sewer Tunnel	City of Columbus	Columbus	OH	Sewer	25,300	18	2010	Bid date 04/28/2010
Olentangy Relief Sewer Tunnel	City of Columbus	Columbus	OH	Sewer	58,000	14	2012	Under design

The editors of Tunneling & Underground Construction encourage UCA of SME members to submit projects to the Tunnel Demand Forecast online at www.smenet.org. The items will be posted on the online TDF once they are verified.

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
Alum Creek Relief Sewer Tunnel	City of Columbus	Columbus	OH	Sewer	74,000	10 to 18	2014	Under design
Black Lick Tunnel	City of Columbus	Columbus	OH	Sewer	32,000	8	2013	Under design
Austin Downtown Tunnel Project	City of Austin	Austin	TX	Sewage	18,600	10	2009	Awarded SAK Construction
Water Treatment Plant #4	City of Austin	Austin	TX	Water intake	15,000	7 to 9	2010	Under design
Waller Creek Tunnel	City of Austin	Austin	TX	CSO	5,300	22	2010	Under design
Belmont - Southport Plant Connection	City of Indianapolis DPW	Indianapolis	IN	CSO	29,000	12	2011	Under design
Pogues Run Tunnel	City of Indianapolis DPW	Indianapolis	IN	CSO	11,000	18	2013	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 funding review
River Mtn. Tunnel #3	Clean Water Coalition	Las Vegas	NV	Waste water	44,000	15 ft	2012	Under design
Alaskan Way Highway Tunnel	Washington DOT	Seattle	WA	Highway	10,500	54	2011	Under design
Third Ave. Subway Tunnel	S.F. Muni Metro	San Francisco	CA	Subway	10,000	20	2011	Under design
Bay Tunnel	S.F. Public Utility Commission	San Francisco	CA	Water	26,200	10	2009	Michels/Jay Dee/Coluccio low bidder
New Irvington Tunnel	S.F. Public Utility Commission	San Francisco	CA	Water	18,200	10	2009	Bid date 03/11/2010
Sunnydale Aux. Sewer Tunnel	S.F. Public Utility Commission	San Francisco	CA	Sewer	4,000	11	2010	Bid date 03/18/2010
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	24,000	18	2010	Under design
SVRT BART	Santa Clara Valley Trans. Authority	San Jose	CA	Subway	22,700	20	2011	Under design
Spadina Line Extension	Toronto Transit Commission	Toronto	ON	Subway	22,000	18	2010	Advertising 1st Q 2010
Elington West Tunnel	Toronto Transit Commission	Toronto	ON	Subway	10 km	20	2010	Under design
Yonge Street Extension	Toronto Transit Commission	Toronto	ON	Subway	15,000	18	2011	Under design
Port Mann	Greater Vancouver Regional District	Vancouver	BC	Water	3,300	10.5	2011	Project delayed
Evergreen Line Project	Trans Link	Vancouver	BC	Subway	10,000	18	2012	Under design
UBC Line Project	Trans Link	Vancouver	BC	Subway	12,000	18	2014	Under design
Kicking Horse Canyon	BC Dept. of Transportation	Golden	BC	Highway	4,800 x 2	45 x 32	2011	Under design

Save the Date

Mark your calendar for these upcoming important industry events. Plan now to attend!

2010 **North American Tunneling Conference**
June 20-23, 2010 • Marriott Waterfront Hotel • Portland, Oregon

2011 **Rapid Excavation and Tunneling Conference**
June 19-22, 2011 • San Francisco, California

2012 **North American Tunneling Conference**
June 9-13, 2012 • JW Marriott • Indianapolis, Indiana

For more information contact: UCA of SME
www.smenet.org • meetings@smenet.org • 800-763-3132 • 303-948-4200
8307 Shaffer Parkway • Littleton, Colorado 80127

First UCA student chapter is established at the Colorado School of Mines

by Brian Harris, chapter president

The first UCA of SME student chapter was recently established at the Colorado School of Mines (CSM) in Golden, CO. The chapter will focus on attracting students interested in the underground construction industry so that they can meet the companies and individuals involved in the design and construction aspects of underground construction. The chapter will also spotlight aspects of the industry, such as underground construction for civil construction, tunnel engineering, geotechnical engineering, microtunneling and tunnel contracting work. The main goal of the student chapter is to educate and provide a learning experience that will allow students to expand their knowledge of the underground construction industry.

The first chaper meeting took place on Nov. 16, 2009. The 14 students who turned out for the first meeting were enthusiastic about the new chapter and eager to be involved with the industry professionals. In addition to discussing the chapter's goals, the group elected officers: Brian Harris, president; Michael Middleton, vice president; Benjamin Larson, secretary and Peter Turlington, treasurer. Raymond Henn, a consultant with Lyman Henn, a division of Brierley Associates, and adjunct professor at CSM, offered to serve as the chapter's faculty advisor. Henn has expertise in heavy construction and engineering and experience in the underground construction industry. These leaders will be a great asset to the chapter and will serve as a foundation to build upon.

The Underground District of Kiewit Construction has helped in establishing chapter by sponsoring meetings and by serving as its industry supporter. Kiewit employees Jeff Petersen, underground district manager, and Matt Swinton, project sponsor, have volunteered to serve as the representatives of the company and will assist in chapter functions and events. Petersen's and Swinton's knowledge of and involvement in project management and underground construction projects will serve as a valuable base of information that can be accessed by the student members.

Other industry professionals in design, construction and consulting have also expressed an interest in getting involved. Gary Brierley, of Brierley Associates, has offered scholarship funds that will be available to UCA of SME student members. David R. Klug, chair of the UCA Executive Committee, has offered support in the future as the chapter grows. With this strong industry support, the student members are prepared to lead the way in establishing the first UCA of SME organization at the collegiate level.

In the future, the chapter plans to become involved on a national scale by sending members to conferences and underground construction job sites and by bringing in speakers from all over the country. These events will allow students to meet professionals in the industry and expand their knowledge of design and construction methods currently practiced.

Overall, the members of the first UCA of SME chapter are excited about the establishment of an organization that will lead to strong industry networking and knowledge of the underground construction business. The chapter looks forward to growing and becoming an example to be followed by other collegiate students interested in underground construction. ■

The students at the first meeting included: (front row, l-r) Ingrid Vik, Brian Harris, J.R. Hudnall, Benjamin Larson, Peter Turlington, Andrew Shaffer and Kevin Mininger. (back row, l-r) Michael Middleton, William Hodder, Brian Evans, Ben Seling, Doug Low, Logan Ronhovde and Matthew Zeke. Chapter members not pictured are Ryan Ostoyich, Eric Smiley, Luke Frash and Sami Mourtada.

How to start a student chapter

A student chapter of SME may be organized at any educational institution of higher learning where there is an existing program in a technical area associated with SME, and where there is sufficient student enrollment and interest.

However, before its proposal can be presented to the SME Board of Directors for approval, a student chapter must have 10 SME student members and must submit the following information.

(Continued on page 55)

AWARDS

Hatch Mott MacDonald/Jacobs Engineering win Engineering Excellence Award

Hatch Mott MacDonald/Jacobs (HMMJ) Engineering received top honors for its deep tunneling design from the American Council of Engineering Companies (ACEC) of Washington. The award was presented at the ACEC's 42nd annual Engineering Excellence awards ceremony on Jan 22, 2010. The ceremony honored 42 projects that represented a wide range of engineering achievements and demonstrated the highest degree of skill and ingenuity. The Platinum Award was presented to Hatch Mott MacDonald/Jacobs Joint Venture for its structural systems engineering of the Beacon Hill Station and Tunnels, Sound Transit Central Link Light Rail Section 710 in Seattle, WA. The new Beacon Hill station is in a neighborhood that was previously somewhat isolated. The new station provides fast, efficient access to Seattle and the SeaTac Airport. The depth and dimension of these tunnels exceeded anything done previously in soft ground in North America.

The winning project team receives the award. From l-r, Steve Bichich (Jacobs), John Walser (Sound Transit), Don Phelps (Hatch Mott McDonald), John Sleavin (Sound Transit) and Steve Mauss (Hatch Mott McDonald).

This award qualifies the project for entry into the national ACEC competition. National award winners and grand conceptors will be announced at the ACEC annual meeting in Washington, D.C. in April. Criteria used for the award includes: original or innovative application of new or existing techniques; future value to the engineering profession; perception by the public; social, economic and sustainable design considerations; complexity and exceeding owner/client needs.

The Beacon Hill station under construction.

Building the tunnel

HMMJ's challenge was to build a deep-mined transit station and 1.61 k (1 mile) of twin, rapid transit tunnels under Beacon Hill. The tunnels needed to be deep, to avoid disrupting businesses and traffic on the surface. Plus, it involved construction in extremely unstable soils, including stratified silt, sand and clay. The station was designed with two shafts, a transverse, two-level concourse tunnel and two platform tunnels.

For the Beacon Hill station and platform tunnels, HMMJ, in conjunction with the Dr. Sauer Company, employed a risk-based design approach. Using this approach, the design team planned the complete

(Continued on page 55)

EXCELLENCE IN PARTNERING AWARD

Lenihan Dam outlet project receives award from the AGC

The Lenihan Dam outlet modifications project was selected as a Special Recognition Winner of the 2010 Marvin M. Black Excellence in Partnering Award by the Associated General Contractors (AGC) of America. The project provided a new outlet tunnel under the abutment of Lenihan Dam.

The award was named for AGC's 1991 president, Marvin M. Black, who was an ardent supporter of the partnering process. This award recognizes the successful partnerships and collaborations that work to improve construction projects. Contractors so honored stand out for their ability in the following areas:

- Signing a formal partnering charter.
- Achieving a common goal.
- Honoring all stakeholders.
- Resolving conflict.
- Improving communication on the project with all audiences.
- Incorporating team-building activities.

This is the second award that the Lenihan Dam outlet modifications project has won. In September 2009, it was recognized as the Outstanding Project in the Large Project Category by the American Society of Civil Engineers, San Francisco Section.

The Lenihan Dam outlet is working at nearly full capacity.

Jacobs Associates played a key role in supplying the tunnel design and construction support services to the project's owner, the Santa Clara Valley Water District. The modification provides the district with an improved system to regulate flow through the dam to Los Gatos Creek, while meeting operational requirements of the California Department of Water Resources, Division of Safety of Dams. Other project team members included MWH, design subconsultant; Flatiron Construction Corp. (FCI), general contractor; Drill Tech Drilling and Shoring, tunneling subcontractor to FCI, and Hatch Mott MacDonald, construction manager. ■

Advanced Concrete Technologies turns 20

Advanced Concrete Technologies (ACT), one of North America's leading providers of turn-key concrete mixing and batching plant equipment celebrated its 20th anniversary in March.

ACT introduced some of the first fully automated concrete production systems available outside of Europe and has grown to work with the full spectrum of concrete manufacturers, producers of precast, pipe, block, paver and architectural products. ACT's full service innovative solution has enabled customers, from multinational companies to privately held businesses, to produce superior quality concrete products with less waste, less labor and greater profitability.

"The past 20 years have been an incredibly exciting time for ACT" said Max Hoene, president of Advanced Concrete Technologies. "Evolving innovations in construction techniques and the introduction of new types of high performance concrete have required increased precision and automation in mixing and batching systems. ACT has been on the forefront of that movement."

Throughout the years, ACT has pioneered and refined several technologies that today deliver productivity, improved plant performance and the flexibility to produce value-added products to increase profits.

In 2007, ACT built a new corporate headquarters in Greenland, N.H. This new facility serves as the North American hub for all customer service, online technical support, parts warehousing ACT's industry-first P3 operator training school, as well as corporate offices for key management, administrative and sales staff. ■

UT-Austin offers online certificate in tunneling

In the fall of 2010, the University of Texas-Austin (UT-Austin) will offer an online Certificate in Tunneling. The course is directed to engineers or engineering geologists with an M.S. and a B.S. in civil engineering, engineering geology or mining engineering who want to obtain a working knowledge of tunnel design or construction management by applying the knowledge acquired in their B.S. and M.S. degrees or professional experience. The program has received provisional endorsement by the International Tunneling and Underground Space Association (ITA). Other courses endorsed by the ITA at the international level include the Polytechnic Institute of Turin and the University of Lausanne.

Since few engineering programs offer a course in tunneling, it is unlikely that young engineers are exposed to tunneling in school. Many owners and agencies built their last tunnel 20-30 years ago, and they lost their tunneling expertise. The certificate is an opportunity to acquire working knowledge through a rigorous and well-structured learning experience beyond the nomenclature that can be acquired at short courses. The online offering allows engineers to continue work on their current assignments and to attend lectures at any time of the day. More than 40 homework assignments are reviewed and graded, allowing students to effectively master the material. A complete syllabus, with charts and tables and application forms, can be found at www.ce.utexas.edu/prof/tonon/ITC.htm.

Certificate program

A rock engineering course with 16 homework assignments offers the basic concepts of engineering geology, a review of relevant mathematics, basic stress, strain and constitutive relationship concepts and an in-depth treatment of rock engineering.

A design and construction of tunnels course with 17 homework assignments covers in-depth basic tunnel mechanics and conventional and tunnel boring machine excavated tunnels.

Ten tunneling-oriented reading and homework assignments review basic coursework at the masters level and apply that knowledge to tunneling. A seminar from an industry speaker introduces the application to tunneling and introduces the relevant homework project. This homework is set up in conjunction with industry partners who are leaders in the field and draws from specific case histories.

The use of RockScience codes Slide, Dips, Swedge and Phase2 is included in the homework. The theoretical background of the codes is explained in the lectures and mastered in the homework by working problems by hand and then checking the results with the RockScience software. Time-sensitive educational licenses are included in the fee and allow students to become familiar with industry-standard software.

More than 40 seminars on tunneling topics by leading international experts, which are about two hours each, will investigate a specific topic introduced in the two courses and bring an industry perspective and case histories into the program. Comprehension questions are assigned at the end of each seminar. Sample seminar topics include: soil engineering for soft ground tunnels, geotechnical baseline reports, risk management in tunneling, best contractual practices for underground construction and construction management in tunneling.

A three-month internship at a construction site is also part of the course. Objectives are established by the program director and the construction site supervisor. A final report addresses how objectives were met and is approved by the construction site supervisor.

There is also a weekly group web meeting with the program director to ensure continuity between course content and homework and to stimulate group discussion. ■

NEW MEDIA

Underground concrete book seeks input

Improving the Application of Concrete in Underground Projects is a guideline manual aimed at improving the specification and use of concrete in underground projects. It is being prepared by a task force of the UCA of SME led by Bob Goodfellow of Black & Veatch. The guideline manual will cover three primary areas of concrete practice: cast in situ concrete, precast concrete segments and shotcrete. Appendices in the manual will provide suggested language for specifications with commentary and a detailed review of admixture chemistry.

The guideline is proposed for publication early in 2011. To assist in that process, industry comment on a draft document is requested at the North American Tunneling Conference in Portland, OR, June 19, 2010. Attendance at the Sunday workshop on technical specifications will provide an opportunity to transmit your comments to the authors directly.

Comments and thoughts are welcomed by the task force. Contact Bob Goodfellow for more information, phone 301-921-2874 or e-mail GoodfellowRJF@bv.com. ■

OBITUARIES

JOHN F. DONOHOE

In memoriam by Arthur B. Corwin, president and chief executive officer, Moretrench

John F. Donohoe, chairman of Moretrench American Corp., died suddenly on Dec. 2, 2009 following a heart attack. He was 67 years old. Donohoe joined Moretrench in 1964, immediately after graduating from the University of Notre Dame with a degree in civil engineering. During the course of a long and distinguished career with the company, he advanced to hold the positions of president, from 1982 to 2002, and chief executive officer from 1995 to 2007. He served as chairman since 1995.

Donohoe was instrumental in many significant projects, notably the design and construction of the largest ground freezing operation in the United States. This operation allowed the jacking of three massive box tunnels beneath South Street Station for Boston's Big Dig. He was a member of the World Trade Center Task Force Committee, where he provided immediate valuable insight to the recovery effort as

DONOHOE

it related to the heavily damaged slurry wall "bathtub" foundations. He led the Moretrench team in the design and installation of critical emergency ground water control systems for the flooded PATH tubes, as well as the Trade Center bathtub to provide stability of the slurry wall for the recovery operation.

Throughout his career, Donohoe was active in the civil engineering community. He served as president of the American Society of Civil Engineers' (ASCE) Construction Institute, president of the Associated General Contractors (AGC) of New Jersey, national director of AGC of America, president of The Moles and president and trustee of the Construction Industry Advancement Program of New Jersey. He was selected as Man of the Year of the AGC of New Jersey in 2001. And in 2004 he received The Moles award for Outstanding Achievement in Construction, a tribute to his lifetime accomplishments. He was a 2009 recipient of the prestigious ASCE Opal Award for innovation and excellence in construction of civil engineering projects and/or programs. Most recently, he was elected president of the General Contractors Association of New York.

Donohoe was a much-valued colleague and personal friend. Throughout his career, he was recognized for his outstanding character and integrity, and he epitomized grace and courtesy. He was a mentor to many and loved by all. With all of his professional achievements, he was still regarded by all as a man of great humility. He will be greatly missed. He is survived by Kathy, his wife of 45 years, and children Kathy, Beth, Margy, John and Ellen. ■

ENGINEERING EXCELLENCE AWARD

(Continued from page 52)

excavation, including the initial and final support systems for the very large diameter shafts and very deep tunnels. In most projects of this size, the contractor hired to excavate also designs the excavation plan. In this case, the engineering design team used the Sequential Excavation Method (SEM) in order to carefully manage the multiple soil challenges. This approach to deep complex tunneling in very poor soils, at a depth and a diameter close to twice that previously done, resulted in the largest soft ground SEM tunnel in North America.

To confirm the geotechnical assumptions made in the preliminary design, a 47.3-m (155-ft) deep, small diameter test shaft provided a three-dimensional finite element analysis of the tunnel excavation and the initial support required, plus final decisions on shaft and tunnel design and construction methods. Test shaft construction led to the successful use of slurry wall construction for the time-critical vertical access shaft. It also guided decisions on how to proceed with SEM tunnels, the use of steel fiber-reinforced concrete for large diameter tunnels and the use of fiberglass reinforcing in slurry walls. This process proved to be a significant advance in the design of SEM tunnels.

Other key innovations in the deep, soft-soils SEM included the dual-side-wall-drift technique for the concourse tunnel and a heading bench invert approach for the platform tunnels. Running tunnels were excavated by an earth-pressure-balance tunnel boring machine and lined with a single pass, precast concrete liner, fitted with gaskets to ensure water tightness. ■

Student chapter

(Continued from page 51)

- Student chapter bylaws.
- A completed student chapter information sheet.
- A letter prepared by the faculty sponsor indicating willingness to serve.
- A letter prepared by the section counselor indicating willingness to serve.
- A completed list of SME student members (minimum of 10 members)

If you have questions regarding student chapter formation, contact Mona Vandervoort, Education Coordinator at SME, 8307 Shaffer Pkwy., Littleton, CO 80127, phone 800-763-3132, ext 227 or 303-948-4227, fax 303-948-4265, e-mail vandervoort@smenet.org. or visit the SME Student Center at www.smenet.org/students. ■

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