



TECHNICAL PROGRAM

UCA Underground
Construction
Association
A Division of SME

NAT2022

**NORTH AMERICAN
TUNNELING CONFERENCE**

JUNE 19-22, 2022
PHILADELPHIA, PA



NAT 2022 TECHNICAL PROGRAM

Monday, June 20, 2022 | 8:30 AM - 9:45 AM | Salon EF, Level 5

Opening Plenary – UCA Awards Session

UCA honors the remarkable 2022 Award Winners. Kick off NAT 2022 and celebrate excellence in the underground construction industry.

UCA AWARD RECIPIENTS

UCA Lifetime Award

William W. Edgerton

UCA Muddy Boots Award

Christophe Bragard

UCA Outstanding Educator

Jamal Rostami

UCA Person of the Year

Leonard A. Worden

UCA Project of the Year \$50M to \$500M

Atlanta Raw Water Supply Program –
City of Atlanta, PC Russell JV, River to Tap/Stantec JV,
River to Tap, Black & Veatch

UCA Project of the Year \$50M to \$500M

Bergen Point WWTP Outfall
Replacement Project – OHLA USA/
Posillico/SELI Overseas

UCA Project of the Year Less than \$50M

Dig Greenville – Reedy River Basin
Sewer Tunnel Project – Renewable
Water Resources, Black & Veatch,
Super Excavators/CMCRAJV

UCA Technical Innovation of the Year

Southland Mole JV Project – Southland
Mole JV, Aldea Services, Robbins

UCA Young Member Award

Aswathy Sivaram

Case Histories: TBM Performances & Challenges I Salon H

10:00 AM

*Chairs: Jimmy McGauley, Barnard Construction Co. Inc., Bozeman, MT
Andre Solecki, Hatch, Mississauga, Canada*

Introductions

10:00 AM - 10:05 AM

The Northeast Boundary Tunnel – A TBM Performance Review

10:05 AM - 10:30 AM

*Authors: Elisa Comis; McMillen Jacobs, Alexandria, Virginia, United States,
Yama Ebrahimi; Belstar Inc., Washington DC, Jeffrey Peterson; District of
Columbia Water and Sewer Authority (DC Water), Washington, District of
Columbia, United States*

Construction of the Northeast Boundary Tunnel (NEBT), the last leg of the Anacostia River Tunnel System on DC Water’s Clean Rivers Project, started in September 2018 and was completed in April 2021. The 26ft- bore earth pressure balance (EPB) tunnel boring machine (TBM) mined 26,737ft at elevations between 80 to 160 feet below ground. Approximately 55 percent of the tunnel was cut through lower predominantly coarse- grained facies (PTX) and the remainder was cut through upper predominantly Over-consolidated fine grained plastic material facies (P/A). Mixed face conditions were encountered in the transition from the P/A to the PTX and vice versa. This paper will review the performance of the TBM that mined the NEBT through several unique challenges, including 8,000 feet (2,440m) of tunneling under the heavily developed Rhode Island Avenue corridor, major sensitive structures, cast iron water distribution mains and other sensitive utilities.

Cutterhead Inspection and Maintenance on the Coxwell Bypass Tunnel Project in Toronto, ON

10:30 AM - 10:55 AM

Authors: William Hodder; JayDee Tunneling Int, Toronto, Ontario, Canada, Ehsan Alavi; JayDee Tunneling Int, Toronto, Ontario, Canada, Muhib Hussain; Jay Dee Cabada, Toronto, Ontario, Canada

Disc Cutter Wear is influenced by several geological and technical factors and excessive wear can have a major impact on the excavation efficiency of Tunnel Boring Machines (TBM). Disc cutter replacement events cause a disruption to the construction schedule, incur extra costs and should be minimized throughout the length of the project. A well-executed cutterhead inspection and maintenance plan can help mitigate abrupt cutterhead interventions and reduce its effect on project schedule and cost. This paper examines cutterhead inspection and disc cutter replacement events as well as subsequent wear data for the 10.5 km long, 6.3 m diameter Coxwell Sanitary Bypass Tunnel in Toronto, Ontario.

Design and Construction of NEORS's Doan Valley Storage Tunnel System

10:55 AM - 11:20 AM

Authors: Dan Dobbels; McMillen Jacobs Associates, Mayfield Heights, Ohio, United States, Tim O'Rourke; Wade Trim, Cleveland, Ohio, United States, Chris Lynagh; McNally Tunneling Corporation, Westlake, Ohio, United States, Rick Vincent; Northeast Ohio Regional Sewer District (NEORS), Cleveland, Ohio, United States, Karrie Buxton; Northeast Ohio Regional Sewer District (NEORS), Cleveland, Ohio, United States

The Doan Valley Storage Tunnel Project in Cleveland Ohio was constructed to control CSOs. It is a complex system of three tunnels ranging from 8.5 to 18 feet in diameter with a total length of about 2.3 miles that was put into operation in mid-2021. The project lies within and below the cultural, educational and medical hub of Cleveland, which presented unique design and construction challenges. This paper provides a case history of the design and construction, with particular attention given to lessons learned in devising a large tunnel system that can carry both dry and wet weather flows constructed in shallow rock within a flood plain area and vibrant urban center.

Seattle's Ship Canal Water Quality Project – Curved Microtunnel Drive

11:20 AM - 11:45 AM

Authors: Chris Breeds; SubTerra, Inc., North Bend, Washington, United States, Dennis Molvik; Northwest Boring, Inc., Woodinville, Washington, United States, Don Gonzales; Northwest Boring, Inc., Woodinville, Washington, United States

Northwest Boring, Inc. deployed a skinned up AVN 2000 Microtunnel Boring Machine (MTBM) to install 118-in OD reinforced concrete pipe sections along an alignment between the Fremont Jacking Shaft and the 3rd Avenue Receiving Shaft for the SCWQ Project. The alignment included: a 67-ft straight section, a 367-ft curved section mined along a 650-ft radius, and a 182-ft straight section. This paper describes the project planning and design, manufacturing, equipment installation in the 90-ft deep Jacking Shaft, egress through the secants and microtunnel operations required to complete the shaft and install the required casing pipes.

Design: Tunnel Lining Design Salon AB

Sponsored by Watson Bowman Acme

10:00 AM

*Chairs: Peter Kottke, Arup, Saint Paul, MN
Hamed Saghaeian-Nejad, Michels Corp, Secaucus, NJ*

Introductions

10:00 AM - 10:05 AM

Hard Rock Pressure Tunnel Final Lining Design Guide Summary

10:05 AM - 10:30 AM

Author: Nick Chen; Jacobs Engineering, Boston, Massachusetts, United States

Pressure tunnel includes water-supply tunnels and tunnels for hydroelectric power plants. Its design principles are different from that of water/wastewater/conveyance or transportation tunnels. Though theoretical pressure tunnel design guidelines exist, a concise guide to summarize these guidelines to facilitate the planning and design of a pressure tunnel program is still needed. The purpose of this paper is to fulfill this need. It first provides key pressure tunnel design concepts in hard rock environment; then, it illustrates associated final lining design principles, including the design of un-reinforced concrete lining, reinforced concrete lining, and steel lining. Design examples will also be provided.

Design of Precast Segmental Tunnel Lining for Pawtucket CSO Tunnel Project

10:30 AM - 10:55 AM

Authors: Irwan Halim; AECOM, Chelmsford, Massachusetts, United States, Seung Han Kim; AECOM, New York, New York, United States, Vojtech E Gall; Gall Zeidler Consultants, New York, New York, United States, Benno Ring; Gall Zeidler Consultants, New York, New York, United States

This paper will describe design of precast segmental tunnel lining for the Pawtucket CSO Tunnel Project in Providence, Rhode Island. The tunnel is 11,700 LF long with 30-foot finished diameter to be constructed in complex sedimentary rocks. Special features of the segments include a large keystone and no connector used on radial joints. The typical segments will be steel fiber reinforced, and hybrid segments with additional steel rebars and shear bicones will be used around the adit openings without use of any structural framing. The important design considerations will be discussed, including special 3D segment to adit connection analyses performed.

Analysis and Design of Tunnel Lining Through a Potentially Displaceable Fault

10:55 AM - 11:20 AM

Authors: Seung Han Kim; AECOM, Oakland, California, United States, Carlos Jaramillo; Marsh Wagner, San Francisco, California, United States, Chu-Chieh Jay Lin; AECOM, Oakland, California, United States, John Roadifer; AECOM, Oakland, California, United States, Mourad Attalla; AECOM, Oakland, California, United States, Theodore Feldsher; Vice President, Dams & Mining Division Manager, Oakland, California, United States

Lifelines in seismic regions of the world seldom can escape crossing active faults. Cities in California have been mitigating this risk constructing improved fault crossings. This paper discusses the analyses and design of the lining for a tunnel carrying a water conveyance pipeline through a fault that can potentially displace during a major earthquake event. The paper presents expected fault displacement, fault width and orientation respective to the tunnel, characterization of the ground surrounding the tunnel and its interaction with the lining, performance required of the lining. Several other fault crossings will also be presented and discussed.

Thrust Jack Loading of Large Diameter TBM Tunnel Lining

11:20 AM - 11:45 AM

Authors: Mike Mooney; Colorado School of Mines, Golden, Colorado, United States, Haotian Zheng, Colorado School of Mines, Golden, Colorado, United States, Clay Naito, Spencer Quiel, Joseph Ouyang, Lehigh University

Large diameter segmental lining systems are increasingly being adopted for highway and transit tunnels in North America. Thrust jack loading becomes a governing segment design load case for large diameter lining. This paper addresses the limit state analysis and design approach used in current practice, the behavior of SFRC and hybrid reinforced segments when thrust jack loaded, and the behavior of 18 in. thick, 45 ft diameter segments subjected to thrust jack loading to failure.

Planning: Underground Project Delivery Salon CD

10:00 AM

Chairs: Albert Soliz, LA Metro, Los Angeles, CA
Jennifer Sketchley, McMillen Jacobs, San Francisco, CA

Introductions

10:00 AM - 10:05 AM

Benefits and Challenges of Progressive Design-Build Procurement – Atlanta Plane Train Project

10:05 AM - 10:30 AM

Authors: Lizan N. Gilbert; Guy F. Atkinson Construction, Austin, Texas, United States, John Murray; McMillen Jacobs Associates, Roseland, New Jersey, United States, Rob Gould; Guy F. Atkinson Construction, Austin, Texas, United States, Daniel Ebin; McMillen Jacobs Associates, Chicago, Illinois, United States, Gabrielle Ferro; Guy F. Atkinson Construction, Atlanta, Georgia, United States

The flexibility of the progressive design-build approach at the Plane Train Tunnel West Extension (PTTWE) Project at Hartsfield-Jackson Atlanta International Airport has provided opportunities for collaboration between the design-builder, design engineer, and owner and the implementation of innovative design and construction approaches. The innovations have in some cases reduced cost and/or improved project schedule. However, in some cases, these approaches were initiated to reduce risk and improve certainty, with an increase in cost to the project. The progressive design-build approach has also allowed for pricing of work to occur in phases. While this has allowed for pricing to be performed with better project understanding and therefore less contingency, the numerous cost proposals have been a challenge for the project schedule. This paper will discuss the benefits and challenges of the progressive design-build approach.

Built to Last? A UK Initiative to Prepare for Future Tunnel Asset Management

10:30 AM - 10:55 AM

Authors: Martin Knights; Chairman LBA Ltd London UK, Dorking, Surrey, United Kingdom

The UK Construction Industry Research and Information Association (CIRIA) is researching and preparing new guidance on Tunnel Asset Management. Engaging with the wider tunnelling community, worldwide, will be crucial in its preparation. When published it will present the current state of the art in terms of good practice and support asset owners preparing for the future, including taking advantage of recent innovations and advances in technology. It will provide the industry with a trusted practical guide that will support technical and commercial decision making and be valuable for a spectrum of stakeholders including consultants, contractors, planners, insurers, academia and government. The paper and presentation will describe the above initiative and share what the authors believe will be future of tunnel asset management.

From Mandate to Milestone: Implementing a Major CSO Program in 7 Years

10:55 AM - 11:20 AM

Author: Justin Carl, RiverRenew, District of Columbia

RiverRenew is a major infrastructure program to address combined sewer overflows (CSOs) to Alexandria, VA's waterways. RiverRenew is one of the most expeditious CSO programs in the United States - resulting from political pressures and a new law requiring the abatement of CSOs by July 2025. This paper will focus on the technical solution - a storage/conveyance tunnel system designed to comply with strict regulatory requirements, the Program's design-build procurement approach to meet the aggressive schedule, and the selection of the right alternative to meet the needs of the community and Alexandria, VA's unique political landscape.

PANEL DISCUSSION

Chair: Matthew Crow

Technology: Construction Innovation Salon G

10:00 AM

*Chairs: Shawna Von Stockhausen, Mott MacDonald, San Jose, CA
Ike Isaacson, Brierley Associates, Milwaukee, WI*

Introductions

10:00 AM - 10:05 AM

E-Power Pipe®: Two-stage Trenchless Method for Long Drives in Small Diameters

10:05 AM - 10:30 AM

Authors: Peter Schmaeh; Herrenknecht AG, Schwanau-Allmannsweier, Baden-Wurttemberg, Germany, Tobias Engel; Herrenknecht AG, Schwanau-Allmannsweier Baden-Wurttemberg

The E-Power Pipe® technology was developed for the trenchless installation of protective pipes and pipelines of 10" to 28" diameter, over long distances of more than 4,000 ft. The two-stage process combines elements from HDD and microtunnelling technology. A MTBM excavates the borehole using a specially designed, temporary jacking pipe. A rack and pinion jacking frame pushes the equipment and pulls in the prefabricated pipestring in a second step. The AVNS slurry microtunnelling machine is equipped with a jet pump. A new generation of small hard rock cutting wheels complements this considerable achievement for the tunnelling industry.

Precision Drilling for the Pardee Chemical Feed Shaft Project

10:30 AM - 10:55 AM

Authors: Ashim Gajurel; McMillen Jacobs Associates, Oakland, California, United States, William Brown; Shaft Drillers International, Mt Morris, Pennsylvania, United States, Thomas Pennington; McMillen Jacobs Associates, San Francisco, California, United States, Emily Sing; East Bay Municipal Utility District

The Pardee Chemical Feed Shaft Project involves construction of two new chemical feed shafts to improve raw water treatment capabilities at the East Bay Municipal Utility District's (EBMUD) Pardee Reservoir in Valley Springs, California. The project includes construction of two 250-foot-deep (76 m), 16-inch-diameter (405 mm) stainless steel chemical feed shafts that penetrate an existing 8-foot-diameter (2.4 m) concrete-lined conveyance tunnel. The design approach required that the shafts be installed within a strict verticality tolerance (0.1%) which necessitated the use of directional drilling techniques. Precision drilling was critical to ensure that the shafts penetrated the tunnel in their planned locations and to ensure the installed chemical feed lines would function as designed. Additional challenges to the project included extremely limited access to the tunnel due a requirement to maintain the tunnel in service during construction. This paper discusses the overall design and construction approach for the project, including unanticipated conditions that the project team faced and how these conditions were managed and overcome through a collaborative approach between the contractor, designer, and owner.

Vintage TBM Cuts Months off Schedule in San Antonio

10:55 AM - 11:20 AM

Authors: Cody Edwards; SAK, San Antonio, Texas, United States, Ross Webb; SAK, San Antonio, Texas, United States

Five miles of soft ground tunnel excavation for the SAWS W-6 project finished months early despite difficult conditions. Success was achieved using TBMs and other equipment built long before most of the crew was even born. The old school means and methods easily adapted to the conditions encountered and were the key to the project's success. Unfortunately, an industry trend is to specify more "advanced" equipment which can sacrifice adaptability or productivity for a perceived reduction in risk. This case history discusses when traditional methods may be the best option.

Innovative Approach for Dust Collection in Tunnel Construction

11:20 AM - 11:45 AM

Authors: Craig Allan; Grydale USA, Seattle, Washington, United States, Andrew Fanning; Grydale, Brendale, Queensland, Australia, Thomas Ioramo; Grydale, Brendale, Queensland, Australia

Underground construction environments, especially those with limited airflow such as shafts, cross passages and stations, necessitate effective dust control. This requires combining existing measures with adapted approaches for more efficient and productive operations, cleaner jobsites and decreased worker exposure to contaminated air. This paper will discuss new configurations and trends in dust collection on Australasian infrastructure projects including WestConnex, Sydney Metro and City Rail Link, all of which have applied innovative methodologies for mobile at-source dust collection. Track-mounted dust collectors operate alongside equipment, hydraulic stepping systems advance with road headers, and compact castor-mounted units are used within cross passage confines.



MONDAY, JUNE 20, 2022 | Afternoon Sessions

Case Histories: TBM Performances & Challenges II Salon H

1:30 PM

*Chairs: Phaidra Campbell, JCK Underground, Seattle, WA
Dave Dorfman, Walsh Construction Company, Warwick, NY*

Introductions

1:30 PM - 1:35 PM

TBM Breakthroughs in Pressurized Conditions – Three Rivers Protection and Overflow Reduction Tunnel (3RPORT) and Northeast Boundary Tunnel (NEBT) Projects

1:35 PM - 2:00 PM

Authors: Raffaele Aliberti; Lane, Seattle, Washington, United States, Filippo Azzarà; Lane, Washington, District of Columbia, United States, Francesco Chiappalone; Lane, Fort Wayne, Indiana, United States, Daniele Nebbia; Lane, Cheshire, Connecticut, United States, Lance Waddell; Lane, Fort Wayne, Indiana, United States

As part of the 3RPORT and NEBT Projects, 5-miles Combined Sewer Overflow Tunnels are excavated with a 19feet diameter Slurry and 26feet diameter EPB Tunnel Boring Machines. Due to the difficult geological and hydrogeological conditions, both tunnels are excavated maintaining a ground support pressure between 2 and 5.5 bar imposing significant challenges to the projects. The first part of the paper describes the general characteristics of both projects while the second part focuses on the challenges and technical details of the pressurized breakthroughs that take place in deep shafts excavated in urban environments as part of the projects.

TBM Tunnel Logistics Management on the Longest Outfall Tunnel in the Middle East

2:00PM - 2:25 PM

Authors: Gary Peach; Mott MacDonald, Wheatley, Oxfordshire, United Kingdom, Hernan Vigil; PORR Construction Qatar, Doha, Doha, Qatar

Long tunnels with only one access shaft pose many programme problems for logistics, combine these with the requirement to drive directly out under the sea bed for 10.2 km, and the programme issues become even more challenging. The Musameer outfall tunnel was one such tunnel and in order to meet and eventually improve on the planned completion date required a complex and extensive management of all tunnel logistics required to support consistent tunneling for a two year period. This technical paper will discuss the management issues and solutions implemented to meet the challenges of the Outfall tunnel construction.

Micro Seismic Monitoring and Analysis for Rock Burst Prone Tunnels Utilizing TBMs

2:25 PM - 2:50 PM

Authors: Gary Peach; Mott MacDonald, Wheatley, Oxfordshire, United Kingdom, Gerald Rosario; STANTEC Consulting International LLC, Chicago, Illinois, United States

Twin 8.5 m diameter, 10 km long headrace tunnels under overburdens of up to 1870 m were excavated for the Neelum Jhelum Hydroelectric Project in north-eastern Pakistan using two main beam gripper Tunnel Boring Machines (TBMs). Rockbursts were encountered and presented a significant danger to personnel and equipment. Micro seismic monitoring was installed to analysis rock burst characteristics and to create a database for future reference. Correlation of rockburst characteristics improved the ability to predict the likelihood, location, severity and number of rock burst events. This paper presents the analysis of the micro seismic data and correlation to rock bursts.

Overcoming Challenges in Tunneling for the Beaver Creek Clean River Project, Albany, New York

2:50 PM - 3:15 PM

Authors: Jerry Wang; CDM Smith, Boston, Massachusetts, United States, Mahmood Khwaja; CDM Smith, Boston, Massachusetts, United States, Greg Bold; CDM Smith, Boston, Massachusetts, United States, William Simcoe; City of Albany, Department of Water & Water Supply, Albany, New York, United States, Rebecca Caldon; City of Albany, Department of Water & Water Supply, Albany, New York, United States, Brian Harris; Drill Tech Drilling & Shoring, Antioch, California, United States, Anthony Hanley; Ward & Burke, Columbus, Ohio, United States

Phase III and Phase IV of the Beaver Creek Clean River Project, Albany, NY, includes microtunnelled construction of 2,320 feet of 48-inch/36-inch internal diameter (ID) conveyance pipe and a roadheader excavated 72-in ID, 550-foot-long tunnel. Notable challenges were encountered during the construction including mixed face tunnel conditions, ground condition that resulted in settlement during shaft construction, and unstable tunnel face conditions. The paper discusses several of the key challenges encountered during construction and selected solutions to construction sequencing and methodology to successfully complete Phase III and Phase IV of the Beaver Creel Clean River Project.

Evaluating the Impact of DSC's on TBM Performance in Devonian Dolomite

3:15 PM - 3:40 PM

Authors: Gregory Colzani; Jacobs Engineering, Berkeley Springs, West Virginia, United States, Emily Thompson; Jacobs Engineering, Fort Wayne, Indiana, United States

The 3RPORT Project, includes a 5-mile tunnel excavated by a 19-foot diameter slurry Tunnel Boring Machine below the city of Fort Wayne, IN. The GBR indicated vuggy to massive argillaceous dolomite within the tunnel alignment. During excavation of the first reach, the TBM encountered zones of cohesive clay and sandstone presented in full face and mixed face conditions. The occurrence of Sandstone was not a "Baselined Condition" described in the GBR for this reach of the alignment. This paper will discuss the methodology to investigate, mitigate and evaluate the DSC impacts on TBM performance.

Mechanized Tunneling in Flowable River Sands – The TBM Drives of the Annacis Island WWTP New Outfall System

3:40 PM - 4:05 PM

Authors: Ulf Gwildis; CDM Smith, Bellevue, Washington, United States, John Newby; CDM Smith, Burnaby, British Columbia, Canada, Edward Kennedy; CDM Smith, Burnaby, British Columbia, Canada, Adeela Sidhu; Hatch, Delta, British Columbia, Canada, Guillaume Roux; Bessac, Delta, British Columbia, Canada

Alluvial deposits of major rivers often provide for relatively uniform tunneling conditions. However, these conditions pose specific challenges due to the tunneling behavior of the granular soils as flowing ground, if unsupported. This paper describes the design considerations and construction experiences gained during the TBM drives for the Annacis Island WWTP New Outfall System in the Vancouver, B.C. metropolitan area. Meeting the design criteria for connecting two deep on-land shafts with an in-river riser manifold required advancing a 5-m-diameter slurry TBM through the Fraser Rivers sands and at a tunnel invert elevation with a baseline hydrostatic head of 3.5 bar.

Design: Design of Underground Spaces Salon AB

Sponsored by Watson Bowman Acme

1:30 PM

Chairs: Paul Savard, MWRA, Chicago, IL
Paul Hetu, HNTB, San Jose, CA

Introductions

1:30 PM - 1:35 PM

Single Bore Versus Twin Bores for Subway Systems

1:35 PM - 2:00 PM

Authors: Mahmoud Sepehrmanesh; AECOM, Mount Kisco, New York, United States, Varya Nasri; AECOM, New York, New York, United States

The purpose of this paper is to outline the advantages and disadvantages of single-bore and twin bores for subway systems. Different aspects such as diameter of the tunnel section (tunnel spaceproofing), configuration of the subway line and stations, impacts on passenger safety and evacuation, ventilation system as well as rail system for each solution were evaluated and compared. In addition, a multi-criterion approach is established in this paper to facilitate the decision-making for these two different subway systems. The practical example of a megaproject has been discussed and the details of the decision-making process have been explained.

What is Dry and Does Your Tunnel Need to Be?

2:00 PM - 2:25 PM

Authors: Adam Bedell; Stantec, Atlanta, Georgia, United States, Brad Crenshaw; Richard Goettle Inc., Jefferson City, Tennessee, United States

Tunnel project contract documents often present groundwater infiltration requirements for components of the underground portions of the project. All too often these documents require quantifiable target inflows for these components, but only refer to them in subjective terms such as “dry”, “manageable”, etc. The Contractor’s definition of these terms will inevitably differ from the Engineer’s definition of these terms. The purpose of this paper is to look at common subjective terms used in documents and provide suggestions for reasonable quantifiable language. Additionally, the paper will provide information and recommendations on relative levels of cost and effort increase needed to provide increasing levels of water cutoff (i.e., achieve “dryness?”).

Design Aspects of Deep Water Distribution Shafts

2:25 PM - 2:50 PM

Authors: Navid Allahverdi; AECOM, New York, New York, United States, Varya Nasri; AECOM, New York, New York, United States

This presentation covers aspects of planning and designing of deep shafts with reference to two water distribution shafts under construction in New York City. The new shafts will be sunk in soil and rock until they connect to existing City Tunnel located more than 700 feet below ground surface. The inside diameter of the shafts is 49 feet for the entire stretch in soil with artificial ground freezing as preferred method for excavation support. Excavation in competent rock will be performed using drilling and blasting technique preceded by a pre-excavation grouting program. Membrane waterproofing with sectioning is prescribed.

Amtrak East River Tunnels Structural Repairs and Reconstruction

2:50 PM - 3:15 PM

Authors: Wern-ping Chen; Jacobs Engineering, Acton, Massachusetts, United States, Daniel McNamee; Jacobs Engineering, New York, New York, United States

The Amtrak East River Tunnels include four tunnels, Line-1 to Line-4, which extend from New York Penn Station in Manhattan, under East River, to Sunnyside Yard in Long Island City. Since fall 2015, Amtrak has initiated a program to repair and reconstruct the century-old tunnels, including structural repairs of all the tunnels and reconstruction of the Line-1 and Line-2 tunnels. The reconstruction includes bench-wall demolition and replacing and installing the following elements in the tunnel: direct fixation track, traction power, signal, communication, and tunnel fire/life/safety components. This paper address design and site investigation challenges and knowledge gained from this program.

Newly Adopted Structure Criteria for BART Underground Facilities – Industry Update

3:15 PM - 3:40 PM

Authors: Samer Sadek; Jacobs Engineering, Northborough, Massachusetts, United States, Phoebe Cheng; San Francisco Bay Area Rapid Transit District, Oakland, California, United States, Changmo Kwon; San Francisco Bay Area Rapid Transit District, Oakland, California, United States, Myat Ohn; Jacobs Engineering, Oakland, California, United States

BART Facilities Standards (BFS) Structural Criteria is a living document that sets the tone for planning, design, and construction of all BART projects. Since its development, the document undergoes incremental changes and updates to reflect policy changes, changes in local, state or national design codes and guidelines, advancements in engineering and technology, or based on the performance of past built infrastructure. In 2020, the BFS-Structural Criteria underwent a comprehensive update. This paper summarizes the updates to the Tunnels and Underground Structures Section of the Criteria, and provides insights to the basis and logics of the requirements.

Planning: Rehabilitation/Fire Life Safety Salon CD

1:30 PM

Chairs: Eleanor Sillerico, Mott MacDonald, London, UK
Steven Lotti, Frontier Kemper, New Hyde Park, NY

Introductions

1:30 PM - 1:35 PM

Tunnel Options for the Mokelumne Aqueducts Resiliency Project

1:35 PM - 2:00 PM

Authors: Stephen Klein; WSP USA, Oakland, California, United States, Ken Johnson; WSP USA, San Francisco, California, United States, Marshall McLeod; East Bay Municipal Utility District, Oakland, California, United States

The East Bay Municipal Utility District (EBMUD) supplies water to over 1.4 million residents of the East Bay through an aqueduct system extending from the Sierra Nevada Mountains to the San Francisco Bay Area. The water is delivered to the East Bay through the Mokelumne Aqueducts, which are comprised of three 82-mile long steel pipelines. Approximately, 10 miles of the aqueducts crossing the Sacramento-San Joaquin River Delta (Delta) consist of pile-supported elevated pipelines and this portion of the aqueducts is recognized to be vulnerable to seismic and flooding hazards. Previous studies evaluated alternatives for mitigating these hazards and increasing the reliability of the aqueducts for the next 100 years. The highest ranked alternatives involve construction of a 16.5-mile tunnel across the Delta and re-routing the existing aqueducts through this tunnel. This paper will discuss the tunnel options being considered for the Mokelumne Aqueducts in the Delta.

Flow Control in Tunnels

2:00 PM - 2:25 PM

Authors: Petr Pospisil; HNTB, Bellevue, Washington, United States, Darold Woodward; HNTB corp., Bellevue, Washington, United States, Stefan Haydn; Inframatic, Camp Hill, Pennsylvania, United States

Most fatalities in tunnel fire events have been caused by the spread of toxic smoke. The control of smoke spread is crucial to providing a survivable environment for egress. A properly designed and tuned feedback control loop is required to achieve a target flow which is slow enough to allow for escape of people under different boundary conditions. It is also helpful in optimizing energy consumption under moving traffic conditions. A reliable feedback flow control system requires sophisticated engineering know-how and experience, careful selection of instruments and controlled variables, and a thoughtful implementation from design through field testing and commissioning.

Underwater Tunnel Repair with Stainless Steel Segmental Liner

2:25 PM - 2:50 PM

Authors: Matthew Goff; Schnabel Engineering, Chadds Ford, Pennsylvania, United States, Shawn Drobny; Ballard Marine Construction, Loomis, California, United States, Russell Lutch; Brierly Associates, Brighton, Michigan, United States

An underwater robotic tunnel repair with new internal stainless steel segmental liners will be installed in 12-ft ID, 100-yr old unreinforced concrete raw water tunnels. Observed cracking in the aging raw water tunnels necessitated structural repairs to isolated sections. Bolted stainless steel segmental liners will be transported and installed underwater with divers and robotic equipment. The new liner was designed using 3D finite element modeling (FEM) for multiple loading and support conditions including sequential grout placement and final condition hydrostatic pressures. The repair will provide an additional service life of 50 years to the aging raw water supply system.

Freight Trains in Tunnels – Operational & Safety Aspects from the Tunnel Ventilation Perspective

2:50 PM - 3:15 PM

Authors: Bernd Hagenah; HNTB Corporation, New York, Washington, United States, Petr Pospisil; HNTB Cooperation, Bellevue, Washington, United States, Dejan Matic; HNTB Cooperation, New York, New York, United States, Sean Cassidy; HNTB Cooperation, Bellevue, Washington, United States, Eric Jones; HNTB Cooperation, Bellevue, Washington, United States, Danielle Johnson; HNTB Corporation, Bellevue, Washington, United States, Hans-Peter Vetsch; Vetsch Rail Consulting GmbH, Buetzberg, Bern, Switzerland

Several issues associated with operating freight trains in tunnels are of high importance during the planning and operation phases. During uphill operation, high air temperatures at air intake locations of diesel trains might reduce diesel motor efficiency (choking). In a fire scenario, ventilation can exacerbate the firefighting efforts due to fanning or water-reactive cargo materials and their chemical reactions with water. The paper focuses on air quality in diesel train-operated tunnels, the impact of freight trains on the tunnel safety concept, and on strategies to overcome heat issues at locomotives air inlets.

Application of Large Diameter Single-Bore Tunnel for Subway Systems

3:15 PM - 3:40 PM

Authors: Jason Choi; WSP USA, Los Angeles, California, United States, Silas Li; WSP USA, New York, New York, United States, Michael Harris-Gifford; WSP USA, Orange, California, United States, William Hansmire; WSP USA, Los Angeles, California, United States

Twin-bore tunnels including a single track in each tunnel are currently the most common subway tunnel configuration. However, a large diameter single-bore tunnel including two tracks separated by a center wall could replace twin-bore tunnels and introduces potential benefits but necessary modifications to the subway system. In particular, a nominal 40 feet diameter single-bore tunnel can be considered in lieu of nominal 20 feet diameter twin-bore tunnels. This paper discusses the benefits and modifications introduced by replacing twin-bore tunnels with a single-bore tunnel, with respect to various elements of subway system related to tunnel, station, tracks, and tunnel systems.

Historic Rock Tunnel Rehabilitation – Designing for the Unknown

3:40 PM - 4:05 PM

Authors: Ryan Marsters; Lithos Engineering, Fort Collins, Colorado, United States, Robin Dornfest; Lithos Engineering, Fort Collins, Colorado, United States, Adam Pring; Lithos Engineering, Fort Collins, Colorado, United States

Raw water supply in the Rocky Mountains often relies on trans-basin conveyance. Many of these diversions incorporate high-elevation, miles-long tunnels driven over a century ago in hard rock. Tunnels were excavated using conventional mining drill-and-blast tactics and weak sections were supported by timber sets and other various means. This presentation will discuss design procedures for assessing obscured bedrock condition, assigning support classes which accommodate for unknowns, and implementing contractual means to address inevitable surprises or quantity overruns. Case studies include several raw water supply tunnels in the Rocky Mountain region constructed between early to mid-20th century.

Technology: TBM Technology Salon G

1:30 PM

Chairs: Heather Stewart, Arup, Toronto, Ontario, Canada
Jeremy Decker, Kiewit, Papillion, NE

Introductions

1:30 PM - 1:35 PM

A Machine Inside a Machine: TBM Innovation in Vancouver, British Columbia, Canada

1:35 PM - 2:00 PM

Authors: Dan Ifrim; Hatch, Oakville, Ontario, Canada, Graham Swarbrick; Hatch, Vancouver, British Columbia, Canada, Bernard Catalano; Bessac, Richmond, British Columbia, Canada

The Annacis Island Outfall Project includes two TBM bored tunnels with face pressures above 3.5 bar, with an internal diameter of 4.2 metres. This paper discusses project innovative approach to TBM tunnelling and Contractor's innovative approach to the Annacis Outfall Tunnel Project. The TBM custom design includes a 3.6m OD Herrenknecht core AVN machine and a 5.0m Bessac add-on, acting as an extension kit, with optimized gantry design to accommodate for short tunnel drives and quicker launches. This novel design approach produced, safety improvement, cost and schedule savings while streamlining logistics of TBM retrieval.

Unprecedented In-Tunnel Diameter Conversion of the Largest Hard Rock TBM in the U.S.

2:00 PM - 2:25 PM

Authors: Steve Chorley; Robbins, Solon, Ohio, United States, Evan Brinkerhoff; Robbins, Solon, Ohio, United States

The largest hard rock TBM ever to bore in the USA, an 11.6 m diameter Robbins Main Beam TBM, recently underwent a planned in-tunnel diameter change to a more compact 9.9 meters. The first-of-its-kind conversion process for the Main Beam TBM was undertaken 2.8 km into the bore, and was not done inside a shaft or pre-excavated portal. This paper will detail the unique dual-diameter machine designed for the Mill Creek Drainage Relief Tunnel in Dallas, Texas, USA, machine performance, and details of the size conversion process that took place in early 2021.

Effect of Machine Parameters and Tunneling Activities on Utilization Factor

2:25 PM - 2:50 PM

Authors: Omid Frough; AECOM, Los Angeles, California, United States, Hossein Changani; AECOM, Los Angeles, California, United States

Application of TBM's is one of the main solutions to achieve a safe and high-performance method of construction in hard rock and soft ground. In order to adequately assess the progress and potential impacts of the tunneling operations with the TBM, it is required to record a series of data during the tunneling process. In this paper, using different case studies' machine data, boring time and other tunneling activities and downtimes as well as changes in transportation system by increasing the length of the tunnel, the effect of these parameter on tunneling performance and utilization factor has been studied.

Hard Rock Tunnel Boring in Challenging Conditions at the Jefferson Barracks Tunnel

2:50 PM - 3:15 PM

Authors: Doug Harding; Robbins, Solon, Ohio, United States, KC Hildenbrand; SAK Construction, O'Fallon, Missouri, United States

The Metropolitan St. Louis Water District's Project Clear is a 28-year program targeting wastewater capacity throughout St. Louis, MO. The extensive program includes the Jefferson Barracks Tunnel, running parallel to the Mississippi River at 2 m i.d and 5,400 m long. A rebuilt Main Beam TBM began boring but hit challenging conditions about 2,400 m in, including water inflows. A larger 4.1 m Main Beam machine will complete the remaining 3,050 m in limestone, dolomite, and shale. The TBM will utilize a high-powered, high breakout torque cutterhead to get through fault zones along with enhanced 360-degree probing & grouting capabilities.

The Next Generation of Mixed Ground Tunnel Boring Machines

3:15 PM - 3:40 PM

Author: Brad Grothen; Robbins, Kent, Washington, United States

What is the most economical way of tunneling in variable geology? What if high water pressure is a possibility? EPB and Crossover mixed ground tunnel boring machines are being adapted for particularly difficult geology where in the past, Slurry TBMs might have been used. This is done with design improvements in high pressure disc cutters, sequential mining methods paired with compressed air and variable conveyor configurations. This paper will analyze machine design, ground conditions and performance of several new design iterations at projects in Turkey, Mexico, China, and more.

TUESDAY, JUNE 21, 2022 | Morning Sessions

Case Histories: SEM/NATM Excavation Techniques Salon H

8:30 AM

Chairs: Ritika Kundu, COWI, Reston, VA
Max Engen, JF Shea, Greenwood, IN

Introductions

8:30 AM - 8:35 AM

Courthouse Commons Tunnel: A Case Study of Modern SEM Tunneling

8:35 AM - 9:00 AM

Authors: Jakob Walter; McMillen Jacobs Associates, San Francisco, California, United States, Drew Mason; Atkinson Construction, Austin, Texas, United States, Yiming Sun; McMillen Jacobs Associates, Walnut Creek, California, United States, John Stolz; McMillen Jacobs Associates, Pasadena, California, United States

The Courthouse Commons SEM Tunnel was excavated with only 6-feet of cover beneath two buildings in downtown San Diego utilizing high precision geo-technical instrumentation. The excavated dimensions are approximately 25 feet in diameter and 328 feet in length connecting two in-service buildings. Pre-support includes large diameter canopy pipes and smaller pipe spiles. Initial support consists of fiber-reinforced shotcrete with lattice girders. This paper presents observed ground and structure behavior and lessons learned. During construction an unanticipated brick structure was encountered and methods were developed to improve adhesion of shotcrete to sandy soil and to reduce rebound.

Underpinning of an Operational Subway Aided by Mined Galleries

9:00 AM - 9:25 AM

Authors: Angelos Gakis; Dr. Sauer & Partners GmbH, Salzburg, Salzburg, Austria, Thomas Schwind, Dr. Sauer & Partners gmbH; Salzburg, Salzburg, Austria, Elmar Feigl; Dr. Sauer & Partners Corporation, Herndon, Virginia, United States, Gerald Skalla; Dr. G. Sauer & Partners Corporation, Toronto, Ontario, Canada

Cedarvale station was constructed as part of the Eglinton Crosstown Light Rail Line, under the operational Yonge-University Line Subway box of Toronto Transit Commission (TTC). The station was constructed as open-cut which necessitated the underpinning of the existing TTC box to minimize the impact on the Subway and allow its unhindered operation. Six mined galleries, each 4m wide by 2.75m high, were excavated sequentially (SEM), immediately under the existing box, to provide the required space for the installation of the main underpinning beams. This novel solution was executed successfully, providing quick access for the main excavation works to commence.

San Diego Courthouse Commons Tunnel: Challenges and Design Solutions

9:25 AM - 9:50 AM

Authors: Yiming Sun; McMillen Jacobs Associates, Walnut Creek, California, United States, Jeremy Stone; McMillen Jacobs Associates, Pasadena, California, United States, John Stolz; McMillen Jacobs Associates, Pasadena, California, United States

Courthouse Commons Tunnel facilitates the secure transfer of inmates between the County Jail and State Courthouse across a city block in downtown San Diego, California. This shallow tunnel was excavated using the sequential excavation method in soft ground. It passes under two tall buildings with foundation cover of 6 feet and also crosses the active San Diego Fault with a design offset displacement of 18 inches. In this paper, key design challenges of tunnel construction are presented: limiting building settlements without using underpinning of building foundations and incorporating an oversized seismic section with seismic joints and crushable backfill.

Design & Construction Challenges for the North Temple Tunnel

9:50 AM - 10:15 AM

Authors: Michael Tinney; Kilduff Underground Engineering, Inc., Denver, Colorado, United States, Todd Kilduff; Kilduff Underground Engineering, Inc., Denver, Colorado, United States

The following paper is a case study of the design and construction of the North Temple Tunnel Pedestrian underpass in Salt Lake City, UT. Kilduff Underground Engineering (KUE) was designer for the 20 foot diameter SEM Tunnel, Design-Build Contract. Geotechnical data indicated challenging ground conditions would consist of silty loose gravel for the majority of the face with soft to medium clays in the tunnel invert. KUE designed a pipe roof as pre-support to stabilize running gravels in the crown, a shotcrete initial liner with lattice girders to be placed sequentially to minimize disturbance of the clays in the invert and a final liner with waterproofing system.

Ground Improvement Works and Construction of Six SEM Adits as Part of the North East Boundary Tunnel in Washington, D.C.

10:15 AM - 10:40 AM

Authors: Basilio Giurgola; Lane Construction, Washington D.C., District of Columbia, United States, Pietro Banov, Lane Construction, Washington D.C., District of Columbia, United States, Federico Bonaiuti, Lane Construction, Washington D.C., District of Columbia, United States, Norbert Fuegenschum; Bemo Tunnelling, Vienna, Virginia, United States

The North East Boundary Tunnel (NEBT) project in Washington, D.C. requires design and construction of several SEM adits which have to be built between lateral shafts and the NEBT-TBM Tunnel. The paper describes ground improvements, the actual excavation, and also the final lining works. Schedule and sequencing restrictions provided some unique challenges which had to be considered when designing and constructing these mostly short, but essential portions of the project.

Design: Challenging Design Issues Salon AB

Sponsored by Watson Bowman Acme

8:30 AM

*Chairs: Ross Goodman, JF Shea, Louisville, KY
Adam Curry, Keller North America, Rockaway, NJ*

Introductions

8:30 AM - 8:35 AM

Design and Construction of a Shallow Twin Tube Bifurcation – Atlanta Plane Train West Extension Project

8:35 AM - 9:00 AM

Authors: Yiming Sun; McMillen Jacobs Associates, Walnut Creek, California, United States, John Murray; McMillen Jacobs Associates, Roseland, New Jersey, United States, Daniel Ebin; McMillen Jacobs Associates, Chicago, Illinois, United States, Rob Gould; Guy F. Atkinson Construction, Austin, Texas, United States, Lizan N. Gilbert; Guy F. Atkinson Construction, Austin, Texas, United States

The Atlanta Plane Train Tunnel Western Extension is being constructed at Hartsfield-Jackson Atlanta International Airport using Sequential Excavation Methods (SEM). The tunnel has shallow ground cover and mixed-face conditions and passes underneath the SkyTrain and MARTA stations and airport terminal buildings. It includes a twin tube bifurcation with a span of over 45 feet and ground cover of 12 feet. A flat roof is being constructed at the bifurcation to maximize rock cover and minimize surface settlements. This paper focuses on design and construction challenges for the bifurcation and tunneling beneath the world's busiest airport, while minimizing impacts to operations.

Three Rivers Protection and Overflow Reduction Tunnel (3RPORT), City of Fort Wayne: Tunnel Alignment and Adit Redesign in Construction - A Schedule Driven Journey

9:00 AM - 9:25 AM

Authors: Matthew Pierce; Black & Veatch, Indianapolis, Indiana, United States, Brad Krumel; Salini Impregilo Lane, Fort Wayne, Indiana, United States, Todd Webster; Jacobs, Columbia City, Indiana, United States

With pre-excavation grouting completed for the Working Shafts and Start Tunnel, and ground water inflows approaching 2500 gpm, constructability and schedule began to drive redesign questions. The Owner, Engineer and Contractor began design modification efforts to raise the base elevation of the Retrieval Shaft and adjust the vertical alignment of the tunnel. Soon after the Construction team requested adit design modifications to address both schedule and reduction of impact due to anticipated high groundwater infiltration. This paper will evaluate original design criteria and actual in-route design modifications and change management to meet the Owner's just-in-time schedule needs.

Design of Montreal Metro Blue Line Extension Tunnel

9:25 AM - 9:50 AM

Authors: Mehdi Bakhshi; AECOM, New York, New York, United States, Verva Nasri; AECOM, New York, New York, United States

The developments of the Montreal metro extension Line 5 -Blue Line- toward northeast are located between the existing Saint-Michel station and Anjou. It consists of 5.8-km long, 9.5m diameter two-track tunnel, five new stations and six auxiliary structures. The tunnel will be excavated by a shielded rock TBM and supported by precast segmental lining system. TBM will be fitted for probing and pre-excavation grouting to control water inflow into the tunnel during the excavation. This paper presents major design aspects of this mega project including alignment, geological condition, spaceproofing, precast segmental lining, interior structure, and geotechnical instrumentation and monitoring.

Can We Mine Yet – Criteria for Grouting Completion in Tunnel Headings

9:50 AM - 10:15 AM

Authors: Jack Raymer; Jacobs Engineering, Tucker, Georgia, United States, Adam Bedell; Stantec, Atlanta, Georgia, United States, Brad Crenshaw; Richard Goettle Inc., Jefferson City, Tennessee, United States

Tunnel project contract documents often include provisions for pre-excavation probing and grouting for areas ahead of the tunnel heading. If grouting triggers are met, tunneling stops, and grouting is performed. There is substantial variation within the underground industry on what criteria are applied to the grout verification hole that is drilled post-grouting and before excavation resumes. The criteria for determination of the effectiveness should be dependent on the geology and local hydrogeologic conditions. The purpose of this paper is to present specific criteria that can be used by a practitioner to determine whether tunneling can resume or if additional grouting is required.

Curved Microtunneling to Reduce Disruption in City Environment

10:15 AM - 10:40 AM

Authors: Daniel Cressman; Black & Veatch, Markham, Ontario, Canada, Allan Rocas; Black & Veatch, Markham, Ontario, Canada, Peter Clarkson; Black & Veatch, Markham, Ontario, Canada, Aswathy Sivaram; Black & Veatch, Markham, Ontario, Canada, Tatiana Chiesa; Metro Vancouver, Vancouver, British Columbia

The City of Toronto plans to construct a 1,350 mm consolidation sewer along the East Don Roadway. The project includes installation of approximately 260 metre of 1,350 mm diameter concrete pressure pipe through microtunneling methods. The sewer alignment crosses underneath a busy 5-lane arterial road and then follows the very narrow East Don Roadway road allowance. This paper discusses the significant challenges overcome to design the slurry microtunnel through mixed face conditions below the groundwater table in a congested road allowance. A curved microtunnel was ultimately required to avoid conflicts with existing utilities, condominium tiebacks and a bridge structure.

Planning: Underground Project Risk Salon CD

8:30 AM

Chair: Mike Wongkaew, HNTB, Bellevue, WA

Introductions

8:30 AM - 8:35 AM

Risk Modeling Techniques for Complex Tunnelling Projects – From Deterministic to Probabilistic Methods: Have we Done Enough?

8:35 AM - 9:00 AM

Authors: Arno Van Droogenbroeck; RiskConsult GmbH, Innsbruck, Tyrol, Austria, Philip Sander; Bundeswehr University Munich, Neubiberg, Bavaria, Germany, John Reilly; John Reilly International, FRAMINGHAM, Massachusetts, United States, Markus Spiegel; RiskConsult GmbH, Innsbruck, Tyrol, Austria

Although the outdated idea of calculating risk as the deterministic product of its likelihood and impact is not entirely a thing of the past, a multitude of organizations have adopted the usage of probabilistic methods for risk analysis, as they better reflect the inherent uncertainty of cost and risk estimates. But are these advancements far-reaching enough in complex environments? This paper explores two advanced modeling techniques for tunnelling projects. A first one models the uncertainty related to changes in excavation and support classes with correlated variables. A second example demonstrates in which cases probabilistic event trees out-perform the classic three-point-estimates.

The State of DRB's in the Tunnel Industry

9:00 AM - 9:25 AM

Authors: Joseph Gildner; Sound Transit, Seattle, Washington, United States, Fred Dunham; Dunham Consulting Services, Elgin, Illinois, United States, Michael Roach; Traylor Borthers, Long Beach, California, United States, David Hatem; Donovan Hatem LLP, Boston, Massachusetts, United States, Michael Vitale; Mott MacDonald, Cleveland, Ohio, United States,

Dispute Review Boards are a highly successful dispute avoidance and resolution tool. In a joint effort between the UCA of SME and the Dispute Resolution Board Foundation (DRBF), the authors embarked on an informal assessment of the state of the DRB practice in the tunnel industry from the point of view of the Contractor, Owner, DRB Practitioner, Attorney and Consultant. The results of this assessment were presented in a panel discussion at the Rapid Excavation and Tunneling Conference (RETC) in June of 2021. This paper presents the results of that session with recommendations for further industry discussion and implementation.

Improved Contracting Practices and Ground Risk Management Using Geostatistics

9:25 AM - 9:50 AM

Authors: Authors: Jacob Grasmick; Maxwell GeoSystems USA Ltd, Golden, Colorado, United States; Bill News; NovoConsult Ltd, Auckland, New Zealand

Geotechnical uncertainty is a significant risk in underground and tunnel construction. While the geotechnical baseline report is a statement representing known ground conditions in a project site, uncertainties in ground conditions and their implications on risk management are generally not quantified. This paper presents a framework to quantify geotechnical uncertainty using geostatistics and translate to ground risk management. In addition, the paper presents a proposed solution for a digital GIS-based GBR, integrating borehole data, 2D sections, 3D models and interpretation/baseline statements with other design elements (e.g., CAD, BIM, etc.) to provide a more comprehensive/informative tender and risk management tool.

Keep 'Em Separated – Managing Contract Interfaces for the Westerly Storage Tunnel (WST)

9:50 AM - 10:15 AM

Authors: Michael Piepenburg; Mott MacDonald, Cleveland, Ohio, United States, Ben DiFiore; Mott MacDonald, Cleveland, Ohio, United States, Lisa Smiley; JayDee Obayashi JV, Cleveland, Ohio, United States, Ryan Sullivan; Northeast Ohio Regional Sewer District, Cleveland, Ohio, United States, Robert Auber; Northeast Ohio Regional Sewer District, Cleveland, Ohio, United States

Pollution to Lake Erie will be significantly reduced by the WST, including a dewatering pump station located in the downstream tunnel shaft. Separate construction contracts for the tunnel and pump station required careful management of the interface risks. A key decision was to decouple the projects by relocating the mining shaft away from the pump station. The need to receive the TBM at the pump station was eliminated by dismantling the 28-ft diameter TBM in the tunnel and up the mining shaft. This paper will discuss how interface risks were successfully managed during design and construction to limit overall schedule impacts.

Bridging the Gap – From Borehole Spacing to DSC Claim Resolution

10:15 AM - 10:40 AM

Authors: Ulf Gwildis; CDM Smith, Bellevue, Washington, United States, Michael Schultz; CDM Smith, Boston, Massachusetts, United States, Gregory Sanders; CDM Smith, Kansas City, Missouri, United States, Kapila Pathirage; CDM Smith, Edison, New Jersey, United States

Adequate understanding of the subsurface conditions along the alignment of a planned tunnel is key for managing project risk. For achieving this understanding, geotechnical borings are conducted during design. Where their spacing cannot reduce the risk of encountering different site conditions (DSC) in-between borings to an acceptable level, supplemental exploration methodologies may be required to bridge the data gap. This paper compares the exploration design approaches of recent TBM projects in the glacial geology of the Pacific Northwest, the sedimentary rocks of the South and the quaternary deposits along the Eastern Seaboard and compares their effectiveness of managing DSC risk.

Updating the GBR Gold Book

10:40 AM - 11:05 AM

Authors: Randall Essex; Mott MacDonald, Tampa, Florida, United States, Daniel Adams; McMillen Jacobs Associates, Seattle, Washington, United States, Amanda Elioff; WSP USA Inc, Los Angeles, California, United States, David Hatem; Donovan Hatem LLP, Boston, Massachusetts, United States, Paul Madsen; Kiewit Infrastructure, Inc, Newburgh, New York, United States, James Morrison; STV Inc, Omena, Michigan, United States

Managing commercial risks associated with subsurface construction may be the greatest challenge the underground industry faces. The Geotechnical Baseline Report (GBR) was developed in the U.S. in an effort to stem increasing litigation in the industry. A GBR guideline document by the American Society of Civil Engineers was published in 1997 (Yellow Book) and updated in 2007 (Gold Book). This paper will overview the core objectives of a GBR, review its role within the Contract, and address key events and lessons learned over the last 15 years that have prompted a second update expected to be published in 2022.

Technology: Innovation Solutions Salon G

8:30 AM

*Chairs: Bradford Miller, MWRA, Chelsea, MA
Renee Fippin, McMillen Jacobs, Walnut Creek, CA*

Introductions

8:30 AM - 8:35 AM

Lateral Deflections and Vertical Control in Tunnel Control Networks

8:35 AM - 9:00 AM

Author: Joern Katzer; Katzer Survey Consulting, Dauphin, Manitoba, Canada

This presentation investigates lateral and longitudinal deflections of tunnel traverses and tunnel control networks. The purpose of this topic is to investigate the influence of measurement uncertainties and error propagation on tunnel control networks and to estimate what precisions are achievable for a tunnel traverse over a given length of tunnel. Further, this presentation will provide mitigative strategies and discuss the importance of gyroscopic surveys to improve the reliability and accuracy of a tunnel traverse.

Slurry Treatment Plants in Mechanized Tunneling Operations – Safety, Performance and Cost Factor for Jobsites

9:00 AM - 9:25 AM

Author: Gino Vogt; Herrenknecht AG, Schwanau, Baden-Wuerttemberg, Germany

In mechanized tunnelling performance, consumption and safety are main factors for jobsites. One of the most important components affecting these, especially in slurry TBM operations, are Slurry Treatment Plants (STPs). Suboptimally dimensioned and designed STPs create bottlenecks for tunneling operation and jeopardize time schedules and performance. Inefficiently planned STPs could drastically increase consumption figures such as electrical power, bentonite, water polymers, etc. Inaccurately selected and treated suspension properties can cause high-risk potentials for the project. This paper debates relevant key parameters for STPs from project start to finish and its results in influencing factors from the manufacturer's point of view.

Long Distance Tunnelling: Challenges and Trends

9:25 AM - 9:50 AM

Author: Karin Bappler; Herrenknecht AG, Schwanau, Baden-Wuerttemberg, Germany

Mechanized tunnelling is undoubtedly one of the most innovative disciplines in the international construction industry. Technological progress in the planning and production of most modern infrastructures is constantly striving for new records on basis of highly specialized solutions and know-how. Humans and technology have accomplished excellent achievements over the past few years in varied, difficult terrain. New length records were set with the 64km long Brenner Base Tunnel and the HS2 Railway system currently under construction in Europe. Cities are building ever longer and more demanding sewage tunnels. The paper highlights on challenges, trends and innovations of long-distance tunnelling projects.

Automation in Segment Production and Integration of Artificial Intelligence

9:50 AM - 10:15 AM

Author: Stefan Medel; Herrenknecht AG, Schwanau, Baden-Wurttemberg, Germany

Automation in segment production doesn't necessarily mean the use of robots. Several other aspects of atomization in the process are available. Herrenknecht has collected many experiences in the automation process of carousel systems for segment production, implemented several robot systems and launched new artificial intelligence-based camera system supporting the production team in the quality control.

Considerations for Conveyor Belt in Tunneling Applications

10:15 AM - 10:40 AM

Authors: Ginger Hustrulid; Semperit, Bonita Springs, Florida, United States

Conveyor belts are a critical component in tunneling projects. This paper reviews current technology in conveyor belts and design considerations. Compounding differences to meet local fire resistant regulations or certain cover characteristics such as higher abrasion resistance or low carbon footprint rubbers for applications are reviewed. Evaluation of fabric belts, steel cable belts and the benefits to each carcass design for a particular use are also examined to help with selection of the proper carcass to decrease downtime from unexpected failures. Finally, this paper takes a look at some of the differences when working in metric versus imperial units.

Emerging Safety & Productivity Technologies for North American Tunneling

10:40 AM - 11:05 AM

Authors: Mike Rispin; Strata Worldwide, Sandy Springs, Georgia, United States, Rob Albinger, David Maust, Mike Walling; Strata Worldwide, Sandy Springs, Georgia, United States

Safeguarding the life and health of workers underground is a top priority. The tunneling industry has seen the development of innovative tools and technologies that make the underground working space more safe and efficient, both in everyday operations, and in the event of an unexpected incident. This paper will look at four technologies finding a place in tunneling:

- Refuge Chambers
- Proximity Detection & Collision Avoidance
- Gas & Environmental Monitoring
- Conveyor Health Monitoring

These are either new technologies, or "new" to the NA industry. Benefits and applicability will be discussed, as well as features which improve upon past capabilities or practices.

Environmentally Friendly Soil Conditioning for EPB TBM: The State of Environmental Considerations in North America and Around the World

11:05 AM - 11:30 AM

Authors: Cristina Oñate; MAPEI Corporation, Naperville, Illinois, United States, Tanner Murt; MAPEI Corporation, Deerfield Beach, Florida, United States

In recent years, environmental considerations have played a prominent role in underground construction projects. The management and disposal of the muck produced by an EPB TBM is an important aspect of this topic. Soil conditioners with higher biodegradability and lower eco-toxicity have been specifically developed to comply with strict regulations of some countries around the world, with the goal of reducing the environmental impact on soil, water, and living organisms. This paper highlights innovative green soil conditioners and how they differ from traditional products. Additionally, environmental considerations for TBM projects around the world and in North America will be examined.

TUESDAY, JUNE 21, 2022 | Afternoon Sessions

Case Histories: Shaft Excavation, Tunnel Rehab & Challenges Salon H

1:30 PM

*Chairs: Stephanie Shelley, Frontier Kemper, Winnemucca, NV
Josh Morton, Granite Construction Inc., Oak Park, IL*

Introductions

1:30 PM - 1:35 PM

Slurry Wall Construction in Coarse-Grained Soils

1:35 PM - 2:00 PM

Authors: J. Andrew McGlenn; McMillen Jacobs Associates, Vancouver, British Columbia, Canada, Gregory Emslie; McMillen Jacobs Associates, Vancouver, British Columbia, Canada, Murray Gant; Metro Vancouver, Burnaby, British Columbia, Canada

The Second Narrows Water Supply Tunnel will ensure system reliability in the event of a major earthquake and increase the Greater Vancouver Water District's capacity to meet a growing population's long-term needs. It includes a bored tunnel between two deep shafts located in North Vancouver and Burnaby, BC, Canada. The support of excavation for the 16-meter-diameter TBM launch shaft consists of 83-meter-deep unreinforced concrete slurry walls. This paper discusses challenges encountered during construction of these launch shaft slurry walls, namely excavation methods and slurry loss, and mitigative solutions implemented to successfully complete the shaft with minimal impact to project schedule.

Construction Challenges of the Anderson Dam Tunnel Project

2:00 PM - 2:25 PM

Author: Ron Drake; COWI North America, Arroyo Grande, California, United States

The Anderson Dam Tunnel Project is a high-priority, urgent project under construction by the Santa Clara Valley Water District in California. The project will provide a new low-level outlet for the Anderson Reservoir enabling the seismic retrofit of the Anderson Dam as mandated by the Federal Energy Regulatory Commission. This paper describes construction of the tunnel through the dam's left abutment involving several faults in challenging and variable soft and hard ground conditions. The construction methods include SEM, hard rock drill and blast techniques, and a mechanized 8-foot (2.5 m) diameter micro-tunneled lake tap.

Unique Challenges for the Construction of PATH's Exchange Place Cross-Passage Tunnel

2:25 PM - 2:50 PM

Authors: Shrey Arora; Kilduff Underground Engineering, Inc., Red bank, New Jersey, United States, Todd Kilduff; Kilduff Underground Engineering, Inc., Denver, New Jersey, United States, James Grillo; Walsh Construction, Little Falls, New Jersey, United States, Eric Schroeder; Walsh Construction, Little Falls, New Jersey, United States

In efforts to improved ingress/egress from the existing subway platforms in PATH's Exchange Place Station, a new 18-foot horseshoe cross-passage tunnel was constructed by Walsh Construction who retained Kilduff Underground Engineering for design of the initial support system. The project presented some unique challenges. PATH service remained uninterrupted, the Contractor was limited to only mechanical excavation means to advance the heading as a result of the proximity to pedestrians on the platform and logistics proved very challenging for the approximate 100-foot-long tunnel excavated in soft Manhattan Schist. This paper will present the design and construction challenges for the project.

Tunnel Rehabilitation through Historic Landslides in Laguna Beach

2:50 PM - 3:15 PM

Authors: Scott Zylstra; Parsons, Laguna Niguel, California, United States, Shimi Tzobery; Parsons, Laguna Beach, California, United States, Trenton Cohen; Mott MacDonald, Los Angeles, California, United States, Derek McDonald; Drill Tech Drilling & Shoring, Corona, California, United States, Joseph Sinacori; South Coast Water District, Laguna Beach, California, United States, Joe McDivitt; South Coast Water District, Laguna Beach, California, United States

The 60-year-old, 2.3-mile Beach Interceptor Tunnel is being stabilized and rehabilitated by using conventional excavation and support. At its southern end, below the prestigious Three Arch Bay neighborhood, the original tunnel alignment passes under a historic landslide where the tunnel was sand-backfilled and capped by bulkheads in 1954 due to severe and caving ground conditions. Video footage of the existing 21-inch clay pipe showed that the pipe was severely damaged, risking a catastrophic sewer failure.

This paper summarizes the thorough investigation and design process, tunnel realignment construction and monitoring, and the notable cooperation between all parties to overcome risk.

Out with the Old, In with the New – How We've Come Full Circle from the Burning River

3:15 PM - 3:40 PM

Authors: Christopher Petta; Mott MacDonald, Cleveland, Ohio, United States, Adrian Naranjo-Castillo; Mott MacDonald, Cleveland, Ohio, United States, Ben DiFiore; Mott MacDonald, Cleveland, Ohio, United States, Richard "Buck" DePew; Northeast Ohio Regional Sewer District, Cleveland, Ohio, United States, Robert Auber; Northeast Ohio Regional Sewer District, Cleveland, Ohio, United States, Nate Long; Jay Dee, Cleveland, Ohio, United States

The Walworth Run stream was bricked-over in the 1800s, converting it to a 16-ft diameter sewer. This Cuyahoga River tributary contributed to the infamous burning river that became the catalyst for USA's environmental movement. The NEORS has been working hard to reduce CSOs here, most recently by diverting Walworth Run's 882 MGD of flow to the new Westerly Tunnel. This had to consider structure age/size, alluvial/glaciolacustrine deposits (requiring several ground support systems, groundwater control), and maintenance of massive flows. This paper examines challenges identified during design that supported the contractor in development of a risk-mitigating plan, culminating to successful implementation.

Conventional Excavation of New Inlet/Outlet Tunnel for Newell Creek Dam, CA

3:40 PM - 4:05 PM

Authors: Xexin Cai; Mott MacDonald, San Ramon, California, United States, Shawna Von Stockhausen; Mott MacDonald, San Jose, California, United States, Isidro Rivera; City of Santa Cruz Water Department, Santa Cruz, California, United States, Kevin Huynh; AECOM, Oakland, California, United States, Maria Chastka; Obayashi Corporation, Ben Lomond, California, United States

The Newell Creek Dam Inlet/Outlet Project is located approximately 11 miles north of City of Santa Cruz, California along Highway 9 in the San Lorenzo Valley. The project will replace the existing inlet/outlet works at the Loch Lomond Reservoir, to improve the City's overall operational efficiency, system performance, and provide a safe and reliable facility for the City's drinking water supply. This paper discusses the overall project configuration, observations and challenges during construction; including tunnel excavation using a roadheader through predominantly Monterey Formation siltstone and siltstone with claystone fragments in a clay matrix, pre-excavation grouting, and the tools utilized to collect, store, and visualize field data.

Design and Construction of Large-Scale Ventilation Caverns on WestConnex's Rozelle Interchange Project

4:05 PM - 4:30 PM

Authors: Denis Tepavac; McMillien Jacobs Associates, Niddrie, Victoria, Australia, Yiming Sun; McMillien Jacobs Associates, Niddrie, Victoria, Australia, Mark Trim; McMillien Jacobs Associates, Niddrie, Victoria, Australia, Alex Kumar; CPB Contractors, Melbourne, Victoria, Australia

Configuration of Rozelle Interchange Project's ventilation system required design and construction of some of the largest and tallest underground civil caverns attempted in Australia. The paper focuses on the technical challenges of designing these caverns within a heterogeneous, generally weak sandstone under high-stress conditions while providing a construction sequence that would align with the contractor's preferred techniques and schedule. Various construction techniques were investigated, but ultimately an observational approach relying on a construction sequence and specialized instrumentation met both the designer's and contractor's requirements. Relevant data obtained from excavations and the construction monitoring program are presented within.

Kramer Tunnel - Construction of the Ventilation Shaft Project in Germany's Southern Alps

4:30 PM - 4:55 PM

Authors: Lukas Walder; BeMo Tunnelling, Innsbruck, Tyrol, Austria, Richard Gradnik; BeMo Tunnelling GmbH, Innsbruck, Tyrol, Austria, Roland Arnold, BeMo Tunneling, Innsbruck, Tyrol, Austria, Raphael Zuber, Staatliches Bauministerium, Weilheim, Bavaria, Germany

The Kramertunnel project in Garmisch-Partenkirchen, Germany was started in January 2020 and includes the construction of the 3,600 m long 2-lane tunnel, the rehabilitation of the exploration tunnel (escape gallery) and also of the construction of an intermediate ventilation shaft with a depth of approximately 90 m and an inner diameter of 4.5 m. The paper gives an overview about the progress on the project and focuses on the geological and logistical challenges during shaft construction.

Design: Innovative Designs Salon AB

Sponsored by Watson Bowman Acme

1:30 PM

Chairs: Claire Maddox, Kiewit

Rob Gould, Atkinson Construction, Seattle, WA

Introductions

1:30 PM - 1:35 PM

A Case Study Establishing Optimization Techniques and The Procedure for Successful Numerical Simulation of Ground-Structure Interaction

1:35 PM - 2:00 PM

Authors: Ali Keneti; McMillen Jacobs Associates, Melbourne, Victoria, Australia, Xavier Ryan; McMillen Jacobs Associates, Melbourne, Victoria, Australia, Shannon Goff; McMillen Jacobs Associates, Auckland, Auckland, New Zealand, Gerardo Sanchez; McMillen Jacobs Associates, Sydney, New South Wales, Australia, Katerina Howard; Tonkin+Taylor for LinkAlliance, Auckland, Auckland, New Zealand

In this study, a FLAC3D model was conducted for ground-structure stability assessment for the pilot tunnel passing under a large shaft excavated in the vicinity of existing structures at Karangahape Station in Auckland, New Zealand. The analysis involved generation of the geometries and construction sequences in Rhinoceros, modelling the existing ground condition, calibration of the simulated in-situ conditions with the observed behavior of the ground, followed by excavation of the shaft and the pilot tunnel. A comprehensive interpretation of the results was then performed accompanied by comparison of the predicted behavior with the observed response of the ground during construction.

Tunnel Load Rating - A Case Study: Port of Miami Tunnel

2:00 PM - 2:25 PM

Authors: Ali Kazemi; Jacobs Engineering Group Inc., Boston, Massachusetts, United States, Nick Chen; Jacobs Engineering Group Inc., Boston, Massachusetts, United States

For the first-time, a load rating is performed to evaluate the capacity of the Port of Miami Tunnel, that is open to traffic since 2014. A total of eleven critical sections were selected to evaluate its response to vehicular loads and surcharges, groundwater, dead loads, and earth pressures. As expected, the resulting load rating values, employing bridge rating procedure to tunnels, are high. This paper also proposes a load rating methodology that includes thrust and moment interaction phenomenon as normally seen for tunnel design to include soil-structural interaction behavior. This methodology can facilitate the industry for tunnel load rating purpose.

Trenchless Utility Relocation Addresses Environmental Impact for Channel Crossing

2:25 PM - 2:50 PM

Authors: Eric Wang; HNTB Corporation, New York, New York, United States, Kevin Moon; HNTB, New York, New York, United States, Christian Brown, HNTB Corporation, Kansas City, Missouri, United States, John Hanifin, Connecticut Department of Transportation, Newington, Connecticut, United States

Value Engineering on Connecticut DOT's Walk Bridge selected the trenchless option for utility relocation to address the channel crossing's environmental concerns. The design and construction considerations of the twin micro-tunnel drives, and associated shafts are presented. Key challenges included vertical alignment selection to achieve minimum one-tunnel diameter stable cover within thin glacial till underlying extremely soft clay, limited choice of pipe and joint materials meeting stringent non-metallic conduit requirements, thermal grout backfill application, and the close proximity of temporary trestle piles. Mitigation measures were developed for potential point loading pipe damage from remnant boulder fragments in the annular space.

Planning: Future Projects Salon CD

1:30 PM

Chairs: Lisa Star, Cal State, Long Beach, CA

Bryce Grimm, Kiewit, Omaha, NE

Introductions

1:30 PM - 1:35 PM

Horizon Lateral: Reliability to Meet Community Needs Today and Tomorrow

1:35 PM - 2:00 PM

Authors: Adriana Ventimiglia; Southern Nevada Water Authority, Las Vegas, Nevada, United States, Ray Brainard; Black & Veatch, Overland Park, Kansas, United States, Amanda Kerr; Black & Veatch, Denver, Colorado, United States

Preliminary design is underway for a new Southern Nevada Water Authority project that will strengthen one of America's most reliable water systems by providing continued, reliable water service to existing and future customers. The Horizon Lateral is a \$1.6 billion water transmission pipeline including 7-10 miles of 108-inch finished diameter rock and soft-ground tunnels. The tunnels will traverse volcanic rock in or around the McCullough Range and the surrounding alluvial basin. The tunneling community will find complete relevance hearing about this critical infrastructure megaproject from a leading wholesale water utility owner with a proven track record for on-time, collaborative projects.

Design and Construction Challenges for the Ellicott City North Tunnel

2:00 PM - 2:25 PM

Authors: Chris Nelsen; McMillen Jacobs Associates, Alexandria, Virginia, United States, Zachary Hollenbeck; Howard County, Department of Public Works, Columbia, Maryland, United States, Edward Cronin; Brown and Caldwell, Richmond, Virginia, United States, Christopher Brooks; McCormick Taylor, Inc, Baltimore, Maryland, United States, Dan Dobbels; McMillen Jacobs Associates, Burlington, Massachusetts, United States

Recent historic floods have inundated the downtown area of Ellicott City, Maryland, resulting in loss of life and significant property damage. The City has developed the Safe and Sound Plan to reduce the risk of flooding in the historic district, which includes a proposed stormwater conveyance tunnel. The deep bedrock tunnel will be ~5,800 feet long, with a minimum internal diameter of 15 feet. Major challenges to overcome include a zone of saprolite of undetermined extent, multiple near-surface structures, and minimal rock cover under an active railroad at the outfall, all while minimizing impacts to the public.

Commuter Rail Tunnel Alignment Studies for the Pennsylvania Avenue Extension, San Francisco

2:25 PM - 2:50 PM

Authors: Sarah Wilson; McMillen Jacobs Associates, San Francisco, California, United States, John Kaplin; McMillen Jacobs Associates, San Francisco, California, United States, Yana Waldman; San Francisco County Transportation Authority, San Francisco, California, United States, Luis Zurinaga, Zurinaga Associates, San Francisco, California, United States

Plans are underway to extend commuter rail service underground into San Francisco. The Salesforce Transit Center (STC) was completed in 2018 and will serve as a new commuter rail station after two future connecting tunnel segments are completed. The southern segment is a 1.6-mile tunnel known as Pennsylvania Avenue Extension (PAX), which is currently in the planning stage with alternative alignments under evaluation including single bore versus twin bore options. This paper will discuss project challenges, including highly variable tunneling conditions in soil and rock, a congested urban project site with limited space for construction staging, alignment crossings of large existing buried infrastructure, and complicated interfaces with future and existing rail operations.

Planning for Emerging Technology Underground Connection Between Rancho Cucamonga Metrolink Station and Ontario International Airport

2:50 PM - 3:15 PM

Authors: Mike Wongkaew; HNTB, Bellevue, Washington, United States, Per Vilhelmsson; HNTB, New York, New York, United States, Brandon Kluzniak; HNTB, Los Angeles, California, United States

Rail access to Ontario International Airport (ONT) has long been a goal of San Bernardino County Transportation Authority (SBCTA) to increase public transit options to ONT and provide incoming ONT passengers more access to San Bernardino County and the greater Southern California region. This paper describes the planning for the Design-Build-Operate-Maintain (DBOM) delivery of an emerging technology tunnel connection between the Rancho Cucamonga Metrolink station and ONT. The paper discusses key technical considerations, challenges, and opportunities; conceptual configuration development; and construction planning and establishment of the footprint for the underground connection.

Deep Rock Wastewater Tunnel in DelCo

3:15 PM - 3:40 PM

Authors: Leszek Glodkowski; Mott MacDonald, LLC, Iselin, New Jersey, United States, Gary Snyder; Mott MacDonald, LLC, Philadelphia, Pennsylvania, United States, Dafydd Chandler; Mott MacDonald, Milissa Hirst; Mott MacDonald, LLC, Philadelphia, Pennsylvania, United States, Charles Hurst; Delaware County Regional Water Quality Control Authority, Chester, Pennsylvania, United States

The Delaware County Regional Water Quality Control Authority (DELCORA) will be adding tunnel infrastructure to its wastewater conveyance system. This program involves the construction of a conveyance/storage rock tunnel and related facilities. The proposed 11-foot (+/-) finished inner diameter, TBM excavated deep tunnel spans over 8.5 mi and lies 80'-120' below the surface, connected to the surface by six vertical shafts. Five vertical shafts provide access for construction and connections to collect flow. This presentation provides project details including data on the rock (gneiss, schist, etc) in which the tunnel will be constructed.

A Tunneler Solution for the Cemetery Brook Drain in Manchester, New Hampshire

3:40 PM - 4:05 PM

Authors: Mahmood Khwaja; CDM Smith, Waban, Massachusetts, United States, David Polcari; CDM Smith, Manchester, New Hampshire, United States, John Harper; CDM Smith, Manchester, New Hampshire, United States, Shawn Lavoie; CDM Smith, Boston, Massachusetts, United States, Frederick McNeill; City of Manchester, Manchester, New Hampshire, United States, Timothy Clougherty; City of Manchester, Manchester, New Hampshire, United States

City of Manchester, NH, is embarking on one of its largest public works projects in history to construct a 12,000-foot-long, large-diameter, conveyance tunnel through downtown Manchester. This area is known for its challenging geology with undulating granitic bedrock profile overlain by fluvial deposits. Understanding the subsurface conditions is key to mitigating project risks, establishing plan and profile for the tunnel, and selecting the most cost-sensitive and technically appropriate tunneling method. This paper presents the project team's approach for conducting the ground investigation, developing preliminary subsurface profile, and for the considerations for selecting the tunneling method.

Technology: Design Innovations Salon G

1:30 PM

*Chairs: Everett Litton, WSP, Saint Louis, MO
Shawn Coughlin, Keller, Rockaway, NJ*

Introductions

1:30 PM - 1:35 PM

Soil Conditioning for Potomac Group Soils in Washington DC

1:35 PM - 2:00 PM

Authors: Raffaele Aliberti; The Lane Construction Corporation, Seattle, Washington, United States, Elisa Comis; McMillen Jacobs, Alexandria, Virginia, United States, Moussa Wone; District of Columbia Water and Sewer Authority (DC Water), Washington, District of Columbia, United States DC Water's Clean Rivers (DCCR)

This program involves the construction of approximately 18 miles of CSO tunnels in Potomac Group soils in the Washington DC area. Soils include an upper predominantly Over- consolidated fine grained plastic material facies (P/A) and lower predominantly coarse-grained facies (PTX). As earth pressure balance (EPB) Tunnel Boring Machines (TBMs) are mainly used in such soils, the correct approach to soil conditioning can make a considerable difference in TBM performance. Soil conditioning laboratory tests are often completed during the planning phase prior to TBM excavation to develop a baseline for soil conditioning, reduce risks, minimize costs, and improve performance. However, only a few basic tests are standardized to date, and conditioning regimes are fine-tuned during the mining phase. The paper illustrates the effort carried out to identify the correct soil conditioning regime for both PA and PTX facies to improve TBM overall performance and reduce ground movement during the excavation of the Northeast Boundary Tunnel (NEBT) in Washington DC.

Predicting Utilization Rate of Hard Rock Slurry TBMs by Discrete Event Simulation Model

2:00 PM - 2:25 PM

Authors: Tala Tahernia; Colorado School of Mines, Golden, Colorado, United States, Jamal Rostami; Colorado School of Mines, Golden, Colorado, United States, Anuradha Khettwal, Colorado School of Mines, Golden, Colorado, United States, Lance Waddell, Lane Construction Corporation

The estimation of TBM utilization could be tricky due to uncertainty involved in the occurrence and duration of downtimes and uniqueness of projects. The CSM-2020 developed by Earth Mechanics Institute team uses single and double shield TBM database in a discrete event simulation model to predict machine utilization. In current study, CSM-2020 was modified to simulate the workflow of slurry TBMs. The operating principle of these TBMs is different than open-mode TBMs. The model was verified by comparing results with a recently completed project in the US. The final model offers estimating utilization for different projects with available geological information.

Applications of Artificial Intelligence in Tunnel Design and Construction

2:25 PM - 2:50 PM

Authors: Kumar Bhattarai; HNTB Corporation, Frisco, Texas, United States, Gunjan Bhattarai, University of Texas at Austin, Austin, Texas, United States

Recently, there has been enormous increase of interest in artificial intelligence and associated machine learning applications by researchers, government agencies, and the underground construction industry. These tools have been heralded and their potential used to automate the design and construction processes and boost productivity, safety, quality, and operational stability. This paper presents applications of artificial neural networks (ANNs) in ground characterization, ground support prediction, risk projection and reduction, and productivity enhancement in the realm of TBM operations. The paper further investigates ANN use in fusion of gathered information to automate TBM operations and reduce risks of tunneling to overlying structures.

Breaking Conway's Law: Getting the Benefits from Integrated Design Automation

2:50 PM - 3:15 PM

Authors: Anthony Harding; Jacobs, South Brisbane, Queensland, Australia, Brian Boye; Jacobs, Cardiff, Cardiff, United Kingdom, David Wright; Jacobs, Birmingham, West Midlands, United Kingdom, Jerome Chamfray; Jacobs, London, London, United Kingdom

Conway's Law states that unless we intentionally design automation tools around what we actually need, we will simply replicate our existing processes. While we may achieve some savings this way, there is an opportunity for greater benefits if we re-imagine the way we, as an industry, do design. This paper examines current technology and shows how even small departures from merely encoding what we currently do could reap significant benefits. From these examples a framework is developed for a new approach to automation that will allow us to design more quickly, to a higher quality, and communicate outcomes more effectively.

How Correct Are Geostatistical Models in Predicting Soil Transitions?

3:15 PM - 3:40 PM

Authors: Rajat Gangrade; Colorado School of Mines, Golden, Colorado, United States, Hongjie Yu; Colorado School of Mines, Golden, Colorado, United States, Mike Mooney; Colorado School of Mines, Golden, Colorado, United States

Transitions between geological/geotechnical soil units will have a critical impact on the operation and performance of a tunnel boring machine (TBM). Probabilistic modeling has been used to predict the soil transition locations within the tunnel envelope. This paper presents two unique case studies where the results from the probabilistic modeling are compared to the as-encountered ground conditions derived from the actual TBM data. The assessment enhances the confidence in probabilistic modeling of soil conditions within tunnel envelope, thus improving ground awareness for efficient tunnel construction, minimizing claims due to unforeseen conditions, and decision-making on tunnel projects.

WEDNESDAY, JUNE 22, 2022 | Morning Sessions

Case Histories: Geotechnical & Contracting Cases Salon H

8:30 AM

Chairs: Daniel Yu, LA Metro, Los Angeles, CA
Paul Headland, Aldea Services, Frederick, MD

Introductions

8:30 AM - 8:35 AM

Analysis of Near Field Vibration Monitoring in Construction Blasting

8:35 AM - 9:00 AM

Authors: Jim Buckley; Guy F. Atkinson Construction, Decatur, Georgia, United States, Robert Cidlik; Guy F. Atkinson Construction, College Park, Georgia, United States, Ryan Sibley; Missouri University of Science and Technology, College Park, Georgia, United States, Thomas Pallua; McMillen Jacobs Associates, Seattle, Washington, United States, Joe Schrank; McMillen Jacobs Associates, Nashville, Tennessee, United States, Scott Giltner; DynoConsult, Louisville, Kentucky, United States

Due to variation in rock type and site conditions, it is important to create site specific prediction models for peak particle velocity (PPV) and understand instrumentation mounting locations to better interpret the readings provided following blasting operations. The Atlanta Airport is expanding the section of underground tunnels for the Plane-Train and drill and blast operations were determined the suitable method of excavation for the project. Extensive work was done to begin creating prediction models and determining levels of concern based on readings from various types of instrumentation. This paper analyzes the effect of close quarters construction blast vibrations and observed frequency spectrum on existing structures with data from twenty-two (22) different seismographs mounted in various locations and ground conditions.

Hybrid Shoring Design for the Courthouse Commons Tunnel in San Diego, California: Controlling and Predicting Ground Movements

9:25 AM - 9:50 AM

Authors: Leigh Anne Zhang; McMillen Jacobs Associates, San Francisco, California, United States, Jeremy Stone; McMillen Jacobs Associates, Pasadena, California, United States, Maryam Motamed; McMillen Jacobs Associates, Pasadena, California, United States

Controlling and predicting ground movements are essential to the design of shoring systems. The Courthouse Commons tunnel in San Diego, California, included a 56-foot-deep temporary shaft as a launching point for tunneling using the Sequential Excavation Method (SEM). The shaft was unique in that it was surcharged on one wall by an 11-story building and employed a hybrid support of excavation design. An array of geotechnical instrumentation was used to monitor the lateral and vertical movements at the ground surface.

This paper compares the measured ground movement and the computed ground settlement using traditional geotechnical methodologies.

Implementation of Vibration Monitoring to Improve Blast Design for the Mitchell Point Crossing

9:50 AM - 10:15 AM

Authors: Sean Sundermann; Kilduff Underground Engineering, Denver, Colorado, United States, Nathaniel White; Kilduff Underground Engineering, Denver, Colorado, United States, Randy Zeiger; LRL Construction, Tillamook, Oregon, United States, Justin Laviolette; LRL Construction, Tillamook, Oregon, United States, Dan Laviolette; LRL Construction, Tillamook, Oregon, United States, Todd Kilduff; Kilduff Underground Engineering, Denver, Colorado, United States

The Mitchell Point tunnel is a part of several ongoing efforts to connect the 12-mile-long Historic Columbia River trail between Mitchell Point Outlook to Mitchell Point Drive. The tunnel lies inside the Mitchell Spur entablature basalt geologic feature, extending 647 linear feet utilizing a typical horseshoe section with a height of 14.5 feet. The Oregon Department of Transportation (ODOT) required proper vibration control to minimize potential impacts to Interstate 84 and Union Pacific rail immediately below the tunnel excavations and sensitive, rare plants. The method of designing the vibration monitoring program and the results of its implementation show the iterative process of using monitoring to improve blast design as excavation proceeds, such as reducing air overpressure and COVID-related supply chain-constraints.

Karst Feature Investigation, Mitigation Design, Specification and Contract Provisions

10:15 AM - 10:40 AM

Authors: Chris Breeds; SubTerra, Inc., North Bend, Washington, United States, Mark Bush; Tetra Tech, Irvine, California, United States, Alissa Lockett; San Antonio Water System, San Antonio, Texas, United States

CWIP Segment 5-1 was the final segment of a Regional Water Supply project that now transfers water from Burleson County to northern San Antonio replacing 25% of that City's water supply. CWIP 5-1 included three tunnel reaches totaling 10,350-ft and 5 shafts that were constructed inside the City in an area known to contain large karst features. This paper describes site work used to investigate the alignment for karst features, manage potential environmental impacts, develop the contract package required for mitigation and the means and methods that were used to mitigate the large karst features that were encountered.

Design: Numerical Modeling Salon AB

Sponsored by Watson Bowman Acme

8:30 AM

*Chairs: Kim Wilson, LA Metro, Los Angeles, CA
Franz Wilhelmstoetter, Dr. Sauer, Herndon, VA*

Introductions

8:30 AM - 8:35 AM

Analytical Behaviour of a Tunnel with Rock Bolts and Shotcrete During an Extreme Fire Event

8:35 AM - 9:00 AM

Authors: Justin Arifin; McMillen Jacobs Associate, Docklands, Victoria, Australia, Dean Newman; McMillen Jacobs Associates, Docklands, Victoria, Australia, Mark Trim; McMillen Jacobs Associates, Sydney, New South Wales, Australia, Michael Behrens; McMillen Jacobs Associates, Docklands, Victoria, Australia

Road tunnels in recent infrastructure projects in Sydney, Australia, are designed to have a fire resistance level of either 4-hour cellulosic fire or 2-hour hydrocarbon fire. Where permanent ground support for tunnels consists of systematic rock bolts and a thin layer of shotcrete, it is important to ensure that during and after the fire event [MJ1] the ground support is designed/predicted not to pose risks to the tunnel occupant. The global behavior of the ground support can be predicted using finite element analysis, and its resistance is derived with consideration of the material strength degradation due to the elevated temperature.

Lateral Rock Load Estimation for Cut and Cover Structures

9:00 AM - 9:25 AM

Authors: Charles Stone; HNTB, New York, New York, United States, Eric Wang; HNTB, Newark, New Jersey, United States

A method for estimating geotechnical rock loads in shallow cut and cover subway stations is presented. Localized geotechnical conditions lead to extreme variation of potential rock loadings within the excavation depth on retaining walls for structures. Actual lateral rock stress on these structures can range from zero to over four times the vertical in-situ rock stress. Primary factors affecting the actual lateral stress include intact and rock mass mechanical properties, excavation sequence, localized tectonic conditions, and potential future adjacent structures. The recommended approach applies Terzaghi's method during concept design, followed by UDEC modelling and stress measurement during final design.

Groundwater Pressure Consideration on Partially Drained Tunnel Lining Rehabilitation Design

9:25 AM - 9:50 AM

Authors: Young Park; AECOM, New York, New York, United States, Irwan Halim; AECOM, Chelmsford, Massachusetts, United States, Paul Roy; AECOM, New York, New York, United States

New tunnel lining was designed for rehabilitation of existing unlined Weehawken Tunnel in New Jersey. Structural assessment using beam spring models was performed for the lining design as drained structure at the invert with waterproofing umbrella. Empirical FHWA guideline was typically adopted for design hydraulic pressures, which recommends full hydrostatic at the crown and ten to twenty-five percent gradual reduction in pressure toward the invert. Finite element seepage analyses were conducted for the actual conditions based on anticipated drainage behind the lining and impact on the structural design.

Considerations will be provided on the existing guideline for design hydrostatic pressures.

Planning: Project Design Salon CD

8:30 AM

*Chairs: Paul Dutton, Mott MacDonald, Seattle, WA
Aswathy Sivaram, Black and Veatch, Markham, ON*

Introductions

8:30 AM - 8:35 AM

Characterizing Gassy Ground and Its Importance

8:35 AM - 9:00 AM

Authors: Barry Doyle; Stantec, Mequon, Wisconsin, United States, Emma Ross; Stantec, Mequon, Wisconsin, United States

This paper presents a 20-year global account of tunneling in gassy ground demonstrating a high probability of schedule delays, cost overruns, worker injuries and fatalities. Gas is often characterized in terms immaterial to design of effective ventilation systems. Consequently, control measures deployed in tunnels bear little relation to manner of entry or rate of inflow at a particular site. Cultural factors play a role in these failures. This paper describes screening a site for hazardous gas to determine if targeted investigation is warranted, and characterizing gas in a manner that provides a basis for design of effective control measures.

Connecting Three Pump Stations, with Tunnels, on an Island, in Charleston, SC

9:00 AM - 9:25 AM

Authors: Kyle White; Black & Veatch, Summerville, South Carolina, United States, Donald Benjamin; Charleston Water System, Charleston, South Carolina, United States, Stephen O'Connell; Black & Veatch, Charleston, South Carolina, United States, Justin Kolster; Super Excavators Inc., Menomonee Falls, Wisconsin, United States

Expansion of the Plum Island Wastewater Treatment Plant requires interconnection of three operating pump stations using only two existing 10-ft diameter shafts for access. These two existing shafts require additional support to allow access 130 feet below grade. Interconnection requires rehabilitation of an existing tunnel, excavation of two new tunnels, and abandonment of additional existing tunnels. Construction has discovered unexpected conditions at the two connection points exposed to date. The CMAR contracting method has effectively accommodated discussion and allocation of risk during preconstruction and construction services.

REM de l'Est Project in Montreal

9:25 AM - 9:50 AM

Author: Varya Nasri; AECOM, New York, New York, United States

REM de l'Est is a new mega project in Montreal including 32 kilometers of automated light rail and 23 stations with a cost of about \$10 billion CAD. The project includes 6 miles of 32 ft excavated diameter single bore double track TBM tunnel and 8 underground stations. A hybrid TBM will be used to bore through the limestone and shale rock and alluvium soil of downtown Montreal. 2 stations will be built in cavern and the 6 others in cut and cover. REM de l'Est project is currently under design and will be issued for bid during 2022.

Technology: Digital Technology Salon G

8:30 AM

Chairs: Tolga Togan, WSP, Newark, NJ
Anna Crockford, Brierley Associates

Introductions

8:30 AM - 8:35 AM

Development of the ITA BIM in Tunneling Guideline for Bored Tunnels

8:35 AM - 9:00 AM

Authors: Vojtech Ernst Gall; Gall Zeidler Consultants, New York, New York, United States, Wolfgang Angerer; Jacobs, Dubai, United Arab Emirates, Jacob Grasmick; Maxwell GeoSystems, Golden, Colorado, United States, Jurij Karlovšek; The University of Queensland, Brisbane, Queensland, Australia, Hichem Zammit; Bouygues Travaux Publics, Guancourt, France

The International Tunneling Association (ITA) Working Group (WG) 22 "Information Modelling in Tunneling" is developing a guideline for the implementation of Building Information Modeling (BIM) concepts for Bored Tunneling Projects. The guideline will primarily cover the use of BIM during the conceptual and delivery phases of a project. It will provide Owners with an introduction to BIM as well as an overview of the current capabilities of BIM and a guide for implementation. Current planning foresees publication of the document in 2022. This paper describes the need for the guideline, its development process, and provides a preview of its contents.

The Use of Cloud Based Geotechnical Software During the Final Design of the New Haven Downtown Storm Sewer Infrastructure Improvement Project

9:00 AM - 9:25 AM

Authors: Michael Schultz, Gregory Sanders; CDM Smith, Kansas City, Missouri, United States

The City of New Haven is planning to construct the Downtown Storm Sewer Infrastructure Improvement project to mitigate on-going stormwater flooding in the Long Wharf District. The proposed project includes a 685 cubic feet per second (cfs) stormwater pump station; and a 975 meter (3,200 linear feet) long tunnel segment with an internal diameter of 3.0 meters (120-inches). This paper presents the aspects of the final design and the use of new tools and techniques to investigate ground conditions and the existence of underground structures from the historic waterfront area. The use of OpenGround Cloud software for data collection direct inputs from the lab and transferring data into other applications (CADD programs) to make better and more efficient use of the data collected is also discussed.

360 - Degree 3D Assessment of Subsurface Water Infrastructure

9:25 AM - 9:50 AM

Authors: Jerome Steinkuehler; Dibit measuring Technique USA Inc., Redmond, Washington, United States, Michael Mett; Dibit Messtechnik GmbH, Innsbruck, Tirol, Austria, Heiner Kontrus; Dibit Measuring Technique USA Inc., Redmond, Washington, United States, Cory Dippold; Mott MacDonald, Buffalo, New York, United States, Kristi Latimer; Mott MacDonald, Buffalo, New York, United States

For decades, tunnels of all types have been a significant part of our infrastructure. In particular, water tunnels carry millions of gallons of fresh water every day to major metropolitan areas and surrounding communities. As a critical piece of public health infrastructure, it is important to inspect the condition of these tunnels regularly to ensure reliable and continuous operation. A specific challenge with water infrastructure is that it's often difficult or impossible to shut down the system for long periods of time to perform the needed inspections. The latest method of tunnel condition assessment is the use of hybrid reality 3-D scan data. Photogrammetric and LiDAR based 3-D data ensure a reliable and objective view of tunnel conditions. The data can be used to support a detailed digital inspection including the compilation of databases that consist of a wide variety of deficiencies such as cracks and spalls within the structure. Mott MacDonald, a design engineer company worked closely with Dibit, used a 360-degree scanning system to collect high-resolution photogrammetric and LiDAR data on a recent project involving a water tunnel. The allows for full 360-degree coverage of the tunnel surface including a water covered invert. It operates at walking speed and ensures a fast and reliable data acquisition which can reduce the time of tunnel shutdowns. Several allocated inspection weeks can reduce to few days, with the final work product being a higher quality and more complete deliverable than traditional inspection methods would have provided. The true-color 3D-model has a photo resolution of 1 x 1 mm (0.039 x 0.039 inches) which makes cracks visible with a width of down to 0.3 mm (0.011 inches).

Implementing BIM Underground on Progressive Design-Build – Atlanta Plane Train Tunnel West Project

9:50 AM - 10:15 AM

Authors: Eric Westergren; McMillen Jacobs Associates, Mayfield Heights, Ohio, United States, Jeff Fontana; McMillen Jacobs Associates, Seattle, Washington, United States, Daniel Ebin; McMillen Jacobs Associates, Chicago, Illinois, United States, Bill Currier; Guy F. Atkinson Construction, Atlanta, Georgia, United States

The Plane Train Tunnel West Extension (PTTWE) Project at Hartsfield-Jackson Atlanta International Airport includes the extension of the existing automated people mover system and terminal renovations at the baggage claim station. To assist with design, pricing, and assessment of risk on this progressive design-build project, 3D design models were prepared to increase visibility into realities of construction. This paper will focus on the original intent of the models and explore the additional, unforeseen value they provided throughout the design and construction process.

Closing Plenary – Tunnel Demand Forecast

10:30 AM - Noon | Salon EF, Level 5

Chair: Jonathan Klug, Vice President, David R. Klug & Associates

The Tunnel Demand Forecast session will have presentations from various owners and engineers regarding upcoming projects throughout the U.S. and Canada. An overall update and summary of North American tunnel projects will also be given. Some of the projects and programs to be discussed will include:

- LA Metro Program Update
- DART D2 Subway, Dallas, Texas
- Amtrak B&P Tunnel, Baltimore, MD
- Canadian Upcoming Projects Update

Each presentation will last approximately 15 minutes with a limited question and answer period to follow. The presentation list is subject to change based on speaker availability.