MAGAZINE

shotcrete

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OUTSTANDING SHOTCRETE PROJECT AWARDS

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FEATURES

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American Shotcrete Association
401 Edgewater Place, Suite 600
Wakefield, MA 01880
Phone: 248.963.0210
E-mail: info@shotcrete.org
Website: **www.shotcrete.org**

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The opinions expressed in *Shotcrete* are those of the authors and do not necessarily represent the position of the editors or the American Shotcrete Association.

Editor's Note: Shotcrete is a placement method for concrete. However, for the sake of readability, the word "shotcrete" is often used either to identify the shotcrete process (method of placement) or the shotcrete mixture (product materials).

Editor-in-Chief
Charles Hanskat

Senior Editor
Alice McComas

Marketing & Advertising Sales
Tosha Meadows
tosha.meadows@shotcrete.org

Managing Editor & Graphic Design
Cara Baker
cara.baker@shotcrete.org

DEPARTMENTS

COVER PHOTO: *Angkor Wat-inspired entrance to Fresno Chaffee Zoo's "Kingdoms of Asia" exhibit, part of our 2025 Outstanding Architecture Project. See the full story on pg. 10*

Inflection Points

By Jason Myers

A change in our Board leadership is a great opportunity to look at the past, present, and future of the American Shotcrete Association (ASA). As I approach my 9th year on the Board and Executive Board, I now have the honor and privilege of serving as President over the next year. After nearly 30 years as an association, reviewing what the ASA has accomplished in the shotcrete industry is essential — reflecting on those I now call friends over my time with the ASA, is an honor.

HINDSIGHT IS 20/20

Looking back on the first and second generations of ASA members, it's amazing to recall the position papers that have been written, the accumulated knowledge within both the shotcrete and general construction industries, the influence on ACI documents, the increase in the quality of shotcrete, and the recognition of shotcrete as an acceptable and often preferable means of concrete placement.

I look at those in the process of finishing out their careers, and the service that they've provided to the ASA — continuing what the founders started. This includes the Shotcrete Contractor Qualification program, Shotcrete Inspector education and certification, as well as continued efforts in bringing design guidance and quality control within the pool industry. Our skatepark members have also stepped up to recognize the same needs within the skatepark industry. That second generation has done a wonderful job of holding up the ASA banner and leading us forward, and we owe our present to the hard work of the past.

NOW AND AGAIN

An inflection point is a point along a curved line that changes its direction from its current path. I believe that we are at one of those inflection points in the ASA.

Ever since COVID, the nature and commitment to service have changed. I've seen it in many different organizations, including the ASA. The strength of our association today is due to the sacrifice, leadership, and efforts of the first and second generations of the ASA membership, but our future is in the hands of those reading this article. Is the ASA going to grow to greater heights, leading to greater acceptance and higher quality in the shotcrete industry?

LOOK DOWN THE ROAD

Our future is where that inflection point directs us next. Will you help contribute to a continued upward trajectory? Membership has never been higher, but true involvement has been mixed. The strength of our past was ASA's members pulling together, working toward common goals, and figuring out a path for the future. It wasn't about the individual or individual companies, but about promoting the shotcrete industry as a whole. Our present political and societal situations are perfect examples of this — they're no longer about the common good, but about selfish needs and immediate satisfaction.

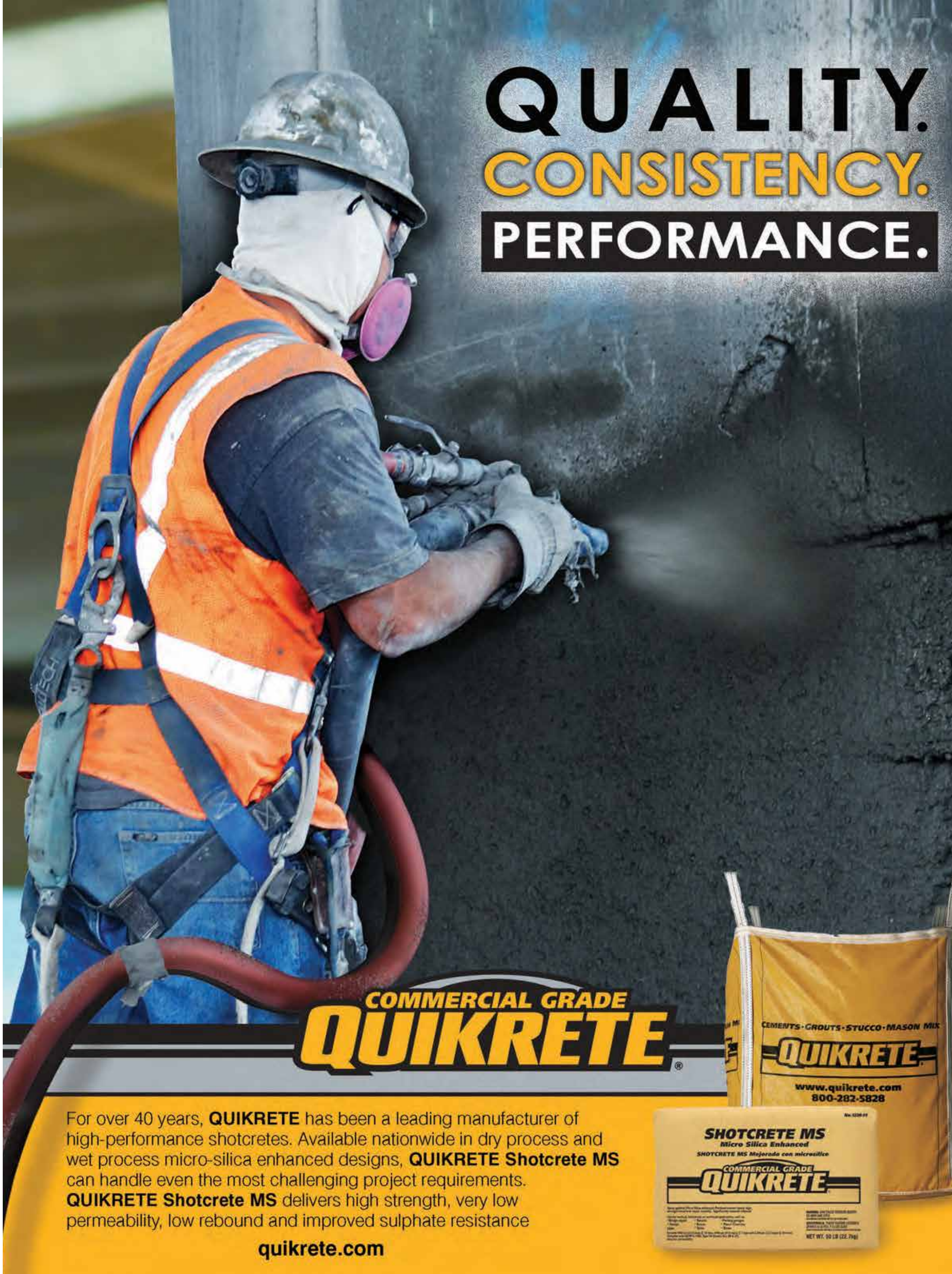
Where is our ASA going in the future? That depends on you: Where are you serving? Are you living off the effort of our shotcrete forefathers, or are you helping to create and form that future? Are you helping to draft and write the shotcrete documents and position papers of the present and future, or are you living off the documents of the past?

Are you going to help shotcrete become a leader in the issues of the future, such as PLC (Type IL) cement, how AI can be used in estimates, the use of robotics and automation, or other things that we haven't even begun to think of? Or are you going to let the decisions and understanding of these issues be up to the opinions and control of others?

LET'S DO THIS TOGETHER

We are all very thankful for the hard work and leadership of our shotcrete predecessors. It's amazing what those dedicated men and women have accomplished in a few short years — they've provided a great framework of understanding, promotion, and acceptance of the shotcrete industry. We have certainly advanced substantially over the last nearly 30 years as an association. The question is this: What are you going to do with the tremendous foundation that has been laid for us?

Let's build on it and sustain their legacy for another 30 years — and beyond.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Marketing Through Membership

By Jason Myers

What is the best way to market your company and the shotcrete industry? I would contend that one of the best ways is through membership and participation in the American Shotcrete Association (ASA). How else can you access:

- The collective knowledge compiled and created by ASA
- Direct connections with industry leaders and suppliers
- ASA members who help create and maintain shotcrete-related documents that ultimately control and regulate our industry

How else can you have a direct impact on the direction the ASA takes to improve quality in our industry by sharing your professional experience and understanding of how quality placement is being implemented? A person can always decide to do all of the above action items themselves, but a smart industry leader uses the resources that are readily available to them — like signing up for membership and active involvement with the ASA.

ADDITIONAL BENEFITS

SAFETY GUIDELINES FOR SHOTCRETE

Some of the most important items that any company wrestles with are safety and the unique challenges facing the shotcrete industry. A company could create their own safety guide, sure — but ASA members can use the latest edition of the ASA *Safety Guidelines for Shotcrete* (SGS) and all its resources, developed by industry leaders to help you develop your site-specific safety plans.

The SGS has been created as a living document that will be continuously updated with new information and the latest industry standards. Through membership and participation, a company leader can help us improve this document in an area that they have experience or insight into.

COMMUNITY

Another essential aspect of ASA membership is connection to your fellow members, who bring an abundance of information and experience to all ASA functions and conventions. I've sat down many times with fellow members to discuss various projects or difficulties, and I've always found new ways to understand and address the issues confronting me. For me, knowing the other leaders and suppliers in the industry often facilitates connections when they are needed — which also shows the importance of not just being a card-carrying member of the ASA, but an active participant.

A person can be a member of the ASA, get the magazine, and throw it in the corner with the rest of the mail — and then wonder why they're getting nothing out of their membership. *A responsible leader is an active participant who gathers all the information presented to them and learns from it.*

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Travis McNamara | Premier Gunite LLC
Zach Carlito | BAM Shotcrete Inc.

QUALITY CONTROL

One of the main growth areas the ASA is working on is quality in the shotcrete industry — and we're seeing the fruits of our labors. Through the development of the ASA Quality Shotcrete Contractor (Structural and Pool) programs, we help elevate the standards of the entire industry. This program is accessible to all shotcrete contractors regardless of ASA membership, but how can a company know what it takes to be a Quality Shotcrete Contractor without being involved? Once again, membership has the privilege of not needing to reinvent the wheel.

RESOURCES

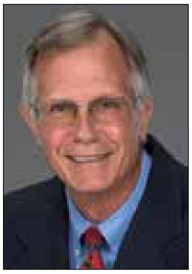
Another benefit of ASA membership is access to and the ability to assist with developing a tremendous library of available articles and papers, along with documentation and resources. This is a tremendous advantage — ASA has a huge selection of resources and programs to aid you in quality shotcrete placement — and as a member you have an even greater privilege to have personal conversations with the people who often helped create the resources. You can be one of those people! Through active participation, it's easy to find the various resources ASA provides and contribute to improving our documents and position papers to advance quality and acceptance in our shotcrete industry.

CONCLUSION

The ASA's main function is to advance the shotcrete industry, and only through a strong membership and active industry leaders will this be successful. Participation may take some time and cost, but doing it on your own will only lead to more of both. Take advantage of the privileges of your ASA membership — and reap the rewards.

ASA Today

By Charles S. Hanskat, P.E., F.ACI, F.ASCE, ASA Executive Director



A BUSY START TO THE YEAR

AWARDS

For the 21st time, we have selected the winning submissions to our ASA Outstanding Shotcrete Project Awards. This issue of *Shotcrete* magazine highlights these winners, each of which exemplifies the quality, creativity, and breadth of applications that shotcrete placement gives to modern concrete construction.

It's never too early to think about which project you would like to submit for the next round of the Awards program, opening in May. Pictures of both in-process and the finished work help to tell the full story: We would love to see your work featured next year and brag about your accomplishments!

ASA Outstanding Shotcrete Project Award Winners

Outstanding Architecture Project
Fresno Chaffee Zoo: Kingdoms of Asia

Outstanding New Construction Project
Point Grey Shoreline Stability

Outstanding Infrastructure Project
Humber College Station

Outstanding International Project
National Route N2 Slope Stabilization

Outstanding Pool & Recreational Project
Southern Living Pools - Yates Project

Outstanding Rehabilitation & Repair Project
Abitibi Canyon Z7 Dam Rehabilitation

Outstanding Underground Project
NYC Grand Central Station New Passageway

HONORABLE MENTIONS

Honorable Mention Project
Pompeys Pillar National Monument Stabilization

Honorable Mention Project
Business in the Front, Party in the Back

Honorable Mention Project
North America's Tallest Retained Façade

WORLD OF CONCRETE

On top of that, already this year we've been a co-sponsor and exhibitor at the January World of Concrete in Las Vegas for the 26th time. It was great to see and chat with our members who came to the booth.

We enjoyed great attendance at our usual full-day educational programs for shotcreters and shotcrete inspectors, and this year we presented a 1.5-hour seminar titled "Shotcrete for Repair", drawing nearly 100 attendees. We also held our annual general membership meeting, with all attendees enjoying the reception that followed.

ASA CONVENTION

Our 2026 annual ASA Convention just wrapped up at El Dorado Hotel and Spa in charming Santa Fe, NM. Be sure to check out the next issue of *Shotcrete* (Q2–2026), where we will feature a recap of the sessions, meetings, and most importantly, images of the camaraderie we enjoyed.

Our Board has approved Nashville, TN, as the host city for our 2027 convention (March 7 – 9, 2027), and we are investigating locations for our 2028 convention, celebrating our 30th ASA Anniversary.

WHAT DID ASA DO IN 2025?

We continued increasing our exposure and acceptance in the pool market. With the input and support of our Pool & Recreational and Contractor Qualification Committees, we rolled out an ASA Qualified Pool Shotcrete Contractor (QPSC) program. The program is similar to our Structural ASA Contractor Qualification, but because most pools are smaller and less complex than most commercial structural projects, this application is tailored directly to the pool market. With this addition, we've modified the ASA's Qualified Contractor seal to reflect the program, Structural or Pool, the contractor has achieved.

Both Contractor Qualification programs recognize shotcrete contractors who have proven their ability to consistently execute quality shotcrete placement with close attention to the fundamentals of proper materials, equipment, and shotcreting technique. Our hope is that, with the credibility of an ASA qualification program closely targeting quality in the pool shotcrete market, we can get rapid acceptance by owners and pool contractors. With a demand from owners and pool builders for quality shotcreted pool shells, we trust that the pool shotcrete contractors who want to positively confirm their commitment to quality shotcrete will pursue qualification through our ASA QPSC program.

We also continue to work with pool industry groups with broad industry exposure to present our full-day "Quality Pool Shotcrete — Know It, Demand It" seminar. This seminar is a tailored version of our Shotcrete Inspector education, geared toward pool builders who subcontract shotcrete placement and pool shotcrete contractors. This is often the seminar presented at the International Pool Spa and Patio Show and other pool shows throughout the year. We worked with Watershape University, a premier pool educational group, which has recognized that ASA is the industry expert in shotcrete education. They have selected ASA to present shotcrete education for their programs. They also offer formalized certifications for pool shotcrete specialists and pool shotcrete inspectors.

Other shotcrete education outreach in 2025 included presentations at:

- ACI and ICRI local chapters
- ACI Resource Centers
- ACI Conventions
- ACI Austin Chapter for a full-day shotcrete inspector class
- Webinars to several engineering firms
- Regional and national pool shows

We've had very strong turnout for shotcreter sessions, with over 100 conducted last year — our thanks go out to Alice McComas for her tireless work in coordinating them, and to our team of 16 ASA/ACI examiners who travel all over the US and Canada to conduct these sessions.

WRAPPING UP

Please take some time to review the Outstanding Shotcrete Project Award winners highlighted in this issue. The creativity, commitment to quality, and wide variety of shotcrete applications continues to impress me every year. 2025 was a great year for the ASA, primarily due to the commitment of our members, officers, board, and staff. We expect 2026 will be just as exciting and make further progress on advancing shotcrete acceptance around the world.

2025 Outstanding Architecture Project

Angkor Wat-inspired entrance to Fresno Chaffee Zoo's "Kingdoms of Asia" exhibit

"Kingdoms of Asia" at Fresno Chaffee Zoo: BRINGING ANGKOR WAT TO CALIFORNIA WITH SHOTCRETE ARTISTRY

By Jared Stanwyck and John Hawkinson

Imagine stepping through a towering stone gateway crowned with a serene Brahma head, flanked by guardian lions, and wrapped in the sinewy roots of untamed ancient fig trees. Beyond the archway, the air feels heavy with jungle mist, and the distant roar of a Malayan tiger echoes through crumbling temple walls. It's easy to forget this is not Cambodia: It's Fresno, California. This breathtaking experience is the result of years of planning, cultural collaboration, and the artistry of COST of Wisconsin Inc., whose mastery of shotcreting transformed a bold vision into reality.

The "Kingdoms of Asia" exhibit at Fresno Chaffee Zoo, which opened to the public in 2023, represents a major achievement in immersive zoo design and construction. This $46 million, 3.5 acre (1.4 hectares) project integrates thematic architecture with creative building techniques, and was recognized by the Association of Zoos & Aquariums with its Top Honor award, a prestigious accolade in the zoo world. More than just a new attraction, it serves as a compelling case study in how shotcrete can bring ambitious architectural visions to life, faithfully recreating elements of the eighth wonder of the world thousands of miles away.

PROJECT OVERVIEW: AN IMMERSIVE JOURNEY THROUGH SOUTHEAST ASIA

"Kingdoms of Asia" transforms the heart of the Fresno Chaffee Zoo into a miniature Southeast Asia. Themed after Cambodia's famed Angkor Wat temple complex, the exhibit features expansive new habitats for several endangered species and vividly recreates the atmosphere of a tropical Asian forest. Visitors enter through a towering gateway resembling a weathered Khmer temple ruin. Atop the gate sits a carved Brahma head, representing the four-faced Hindu deity. Flanking the path are two hulking “Singha” stone lions, mythical guardians from Khmer mythology symbolically protecting the realms beyond. Passing under this elaborate portal, guests leave Fresno behind and step into a world of antiquity — crumbling stone walls entangled with faux fig tree roots and lush vegetation, with the calls of exotic animals echoing through the air.

Inside, the exhibit is laid out as a series of zones highlighting the wildlife of South and Southeast Asia. Malayan tigers roam overhead across two interconnected forest habitats, slipping in and out of temple corridors. A clear underwater viewing window lets visitors watch the tigers swim in a stream that runs through the temple courtyard, a favorite activity, since “tigers … love the water,” according to Fresno Chaffee Zoo CEO, Jon Dohlin. Nearby, a pair of Sunda gharials lurk in a moat-like pool amid stone ruins, and a family of sloth bears snuffle around a tree-shaded grove they share with small-clawed otters. Siamangs swing and whoop in the canopy, while the zoo’s orangutans look on from their renovated ‘treetop’ exhibit, which now seamlessly adjoins the Kingdoms of Asia realm. In total, the exhibit provides homes for dozens of animals of eight distinct species from Komodo dragons to Asian songbirds.

All these spaces are connected by winding visitor pathways designed to evoke a sense of exploration through ruins. Guests walk under archways being ‘strangled’ by vine-like roots, past mossy shrine sculptures, and over footbridges with carved balustrades. Educational signage and cultural details accompany the visual experience as well. In one spot, visitors learn how the exhibit’s realistic fig tree roots mirror what real fig trees have done to Angkor Wat’s masonry over the centuries. An interpretive center, styled as an archaeological field house, shares stories of Southeast Asian cultures and diaspora. Inside this education building, actual artifacts and reproductions honor the people behind the animals.

“Everybody has come from somewhere,” says Dohlin. “This exhibit is about connecting those journeys of people, of cultures, of wildlife — and showing how deeply intertwined they are.”

The project was years in the making. Funded by Fresno County’s Measure Z, design work began around 2019, and construction began in earnest in early 2021. By June 3, 2023, “Kingdoms of Asia” had its grand opening, with more than 8000 visitors pouring in during the first weekend. It was an instant hit.

Guests walk under part of a fig tree that has overtaken the ruins

The amount of intricate detail is what makes this new expansion so immersive

Untamed ‘fig trees’ strangle the ruins throughout the expansion

Viewing area of habitat with crumbled stone ruins scattered about

DESIGN & CULTURAL COLLABORATION: HONORING A SACRED THEME

CLR Design is known for zoo projects that marry thematic storytelling with animal welfare. They worked on reflecting the advisors' input in the plans, refining the look of everything that would be fabricated while ensuring the environments would meet the animals' needs.

On the construction side, COST of Wisconsin, Inc. also consulted the committee's cultural experts during fabrication. COST's project director and artists often met with community elders to verify that a particular statue or mural they were carving in concrete was acceptable. In one case, the team was sculpting a replica of a famous bas-relief depicting warriors on elephants. Photographs of the work-in-progress were sent to a local Cambodian Buddhist temple for feedback; the monks' responses helped the sculptors adjust postures and facial expressions to match those of the 12th-century originals. Such synergy between modern builders and cultural tradition enriched the project immensely.

Specialized painting of the ruins that include 'natural wear' and lichen growth

Artists hand-carve in extreme heat surrounded by sheets to disperse direct sunlight

Fresno Chaffee Zoo convened a special Cultural Advisory Committee early in the design phase as well. This five-member panel included respected representatives from the local Cambodian, Thai, Vietnamese, Hmong, and Laotian communities many of whom have direct ties to the art and faith traditions depicted in the exhibit. One advisor, Danny Kim (a Fresno police sergeant of Cambodian heritage), traveled to Cambodia and had family roots near Angkor. "It looks like you're traveling back to Cambodia," Kim remarked proudly during a preview tour, reflecting the overwhelmingly positive reaction from the Southeast Asian community.

BUILDING THE VISION: TEAM EFFORT IN CONSTRUCTION

One of the first steps was erecting complex prefabricated reinforcing bar frameworks to outline the shapes of things to come, including the ruins, rock outcrops, and big tree trunks. For instance, the entry gate structure was built with a steel structure and reinforcing bar cages. This provided the structural backbone for shotcrete placement. In other areas, pre-shaped foam and wire mesh were used as fillers to bulk out large features without adding excessive weight. COST's designers, back in Wisconsin, had prepared 3D models for many of the components. Using those models, they prefabricated certain pieces to streamline on-site work. According to COST's President, Michael Schmuhl, "We created sections of the temple ornamentation in our shop, essentially practice runs, to ensure we could achieve the level of detail required." These prefabricated

Extreme details inspired by actual aspects of Angkor Wat can be found everywhere

Serpents carved into temple ruins overhead

ABOVE & BELOW: *Blending habitats with architectural details provides depth to immersion*

elements, such as small deity statues and decorative friezes, were cast in glass-fiber-reinforced concrete (GFRC) and later embedded into the shotcreted concrete on site, combining the efficiency of casting with the seamlessness of hand-sculpting.

SHOTCRETE PLACEMENT IN ACTION: SCULPTING A LOST TEMPLE

At the heart of the "Kingdoms of Asia" construction is the extensive use of shotcrete placement to create naturalistic ornamentation. Shotcreting turned out to be the perfect placement method for this job, because it allowed artisans to spray concrete onto irregular, vertical, and overhead surfaces, then sculpt it to shape, which is far more efficient than traditional form-and-pour methods.

WHY SHOTCRETE PLACEMENT?

In themed construction, shotcrete placement is the go-to technique for simulating rock outcroppings, building facades, ponds, and irregular shapes. In the zoo world, it's been used for decades to form artificial rocks in animal habitats. What's special about "Kingdoms of Asia" is that the shotcrete wasn't just forming rocks; it was creating intricate architectural features with painstaking detail. This went far beyond carved lintels, statues, and faux plaster walls. When recreating the eighth wonder of the world, the bar for craftmanship was nothing short of exceptional. For a true immersive experience, the finish had to perfectly match carved stone ruins — not just natural rock.

APPLICATION & SCULPTING

Before the shotcreted concrete set, sculptors carved bark texture and twists into it, even pressing in real fig bark and vine cuttings to create authentic patterns. Vines were added later to give them a distinct winding look. The result is an overhead root that appears to suspend naturally, complete with tendrils and bark that look and even feel real. Having the ability to seamlessly carve such intricate detail on site is what makes shotcrete the perfect medium.

CONCRETE MIXTURE & FINISHING

For the exhibit's rockwork and temple facades, a fiber-reinforced concrete mixture was shotcreted. Polypropylene fibers in the mix help control shrinkage cracking and add a bit of tensile strength, useful for thin sculpted edges like the ears of the stone lions. The mixture design balanced strength with a specified compressive strength of ~4000 psi (28 MPa) with workability. Sand gradation and plasticizers gave it a pumpable consistency and a sticky quality, so it would adhere to vertical surfaces. After the initial sculpting and curing period, crews returned to apply stains and pigment washes. Using thematic techniques, they layered on different colors: Black washes to accentuate recesses and simulate shadowy grime, mossy green dappling in damp-looking areas, and sandy beige tones on highlights to mimic sun-bleached stone. The coloring process turned gray concrete into convincing ancient ruins. Additionally, certain surfaces were treated with acid etching to expose aggregate and give a rough, sandstone-like texture, while others were gently sandblasted for a worn effect. When you run your hand along the temple wall in the exhibit, it's hard to believe it's not centuries old — a triumph of artisanship and materials science working together.

Another noteworthy technical aspect was building the animal-facing features to be robust. For example, inside the tiger exhibit, a fake 'temple column' also doubles as a scratching post. It's textured and impregnated with scents that attract the tigers. This piece was reinforced with extra steel and a higher-strength shotcrete mixture, because a 320 lb (145 kg) tiger can exert significant force with claws and bodyweight. Similarly, edges around pools and steps in the bear habitat were rounded and toughened to withstand digging and wear. Non-toxic sealers were applied over the cured shotcrete in water-contact areas to make them impermeable and easier to clean. These behind-the-scenes measures ensure the beautiful work remains safe and intact under animal use.

Guests walk down pathways where ancient stone motifs blend with natural landscape

Innovations & Challenges Overcome

While much of the shotcrete placement used well-established techniques, the project did present some innovations and learning moments:

- **Hybrid Precast and In-Situ Method:** As mentioned, the team combined prefabricated GFRC pieces with in-place shotcrete. For instance, the intricate apsara dancer carvings on one wall were referenced from actual Angkor Wat carvings. These panels were set in position, and then concrete was shotcreted around them to embed them into the larger wall, blending edges seamlessly. This hybrid approach saved time on-site while still providing meticulously detailed results.
- **Precision Carving with Reference Grid:** To help sculptors hit their marks on proportion and scale, a laser grid and chalk lines were used on the cured base coat before adding details. For example, the Brahma head atop the gate was roughed out in shotcrete and then a grid was lightly etched on its surface. The sculptor, working with a reference drawing divided into corresponding grid squares, could then carve with confidence that the features (eyes, nose, etc.) were correctly placed.
- **Adapting to Weather:** Fresno summers are hot, 100 °F (38 °C) is common, which can cause shotcrete to cure too fast or crack. To mitigate this, major shotcrete placements were done in early morning or evening shifts. They also used misting and evaporation retardants on fresh work. During an extreme heat week, the crew erected shade tarps over active work zones.

A way finder welcomes guests to "Kingdoms of Asia"

Conclusion: A Triumph of Theme and Technique

Walking through "Kingdoms of Asia" today, it's easy to forget all the planning, effort, and cutting-edge shotcrete placement work. That's perhaps the best compliment to the project's success. It feels authentic and effortless, as if Angkor Wat truly sprang up in the middle of Fresno, as magical as it is educational. By melding cultural inspiration with shotcrete innovation, the team created an exhibit that engages on every level: Visually stunning, biologically enriching, and emotionally resonant.

This project is a showcase of what can be achieved with vision and skill. It demonstrates that shotcrete placement isn't just for bridges or pools or tunnels — it's also an artistic medium capable of delivering architectural art on a grand scale.

The Malayan tiger habitat includes a walkway on top of the temple ruins

2025 OUTSTANDING ARCHITECTURE PROJECT

Project:
Fresno Chaffee Zoo: Kingdoms of Asia

Project Location:
Fresno, CA

Shotcrete Contractor Company:
COST of Wisconsin*

Architect Company:
CLR Design

Engineer Company:
Patrell Engineering

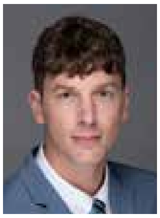
Materials Supplier Company:
Builders Concrete Inc. & Outback Concrete

Equipment Manufacturer Company:
REED Shotcrete Equipment*

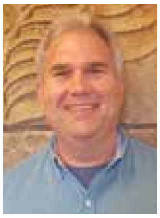
General Contractor:
Bernards Bros

Owner:
Fresno Chaffee Zoo

**ASA Sustaining Corporate or Corporate Member*



Jared Stanwyck *is the Marketing Manager for COST of Wisconsin Inc., a family-owned theme and specialty construction company that started in 1957. Jared has experience in fabrication, project management, estimating, and operations, along with gunite and cast work in his previous role at Refractory Service, Inc. While his educational background is in Mechanical Engineering from Valparaiso University and Operations Management from University of Wisconsin, he loves being able to showcase the beautiful work COST's talented crews perform on a daily basis.*



John Hawkinson *holds dual master's degrees in architecture and urban planning from the University of Wisconsin–Milwaukee. He leads the Pre Construction team at COST of Wisconsin, Inc., bringing more than 25 years of zoo exhibit experience shaped by a deep appreciation for historic architecture and the outdoors. His expertise was utilized in the early stages of the "Kingdoms of Asia" project, where his background helped develop concepts and construction methodologies that supported the exhibit's thematic vision.*

2025 Outstanding Underground Project

New York City Grand Central Station New Passageway

By Louis Falco

INTRODUCTION

The prestigious Grand Central Station is located in a major hub center of New York City bound by East 42nd Street (south), Lexington Avenue (east), East 51st Street (north), and Madison Avenue (west). As one of the major hub centers, it serves over 25 million customers a year using multiple lines with the New York City Transit Subway Lines 4, 5, 6, Flushing Line #7, Shuttle to Times Square on 42nd Street, the Long Island Railroad (LIRR), Metro North Railroad, and New York City Transit (NYCT) entering and exiting the Grand Central Terminal.

The underground area showed signs of congestion and patron queueing issues. With an anticipation of increasing ridership as well, the Metropolitan Transportation Authority Construction and Development (MTA C&D) team planned to implement solutions to address these issues, plus improve passenger circulation, access, and egress within the Grand Central Station area. The Circulation Improvements at Grand Central Station consisted of various construction projects aimed at improving access and egress for Lexington and Flushing Line commuters at the 42nd Street – Grand Central Station location. It should be noted that the project site was located at the intersection of East 42nd Street and Lexington Avenue in the midst of important and historic landmarks such as the Mobil Building (southeast corner), Chrysler Building (northeast corner), Chanin Building (southwest corner), and the Hyatt Hotel and MTA building on the northwest corner.

Fig. 1: NYC Grand Central Station/Terminal area; project site located at the bottom of the picture

This article will discuss the project's construction of the Grand Central Station New Passageway involving the extension to the existing Flushing Line Passageway and installing an additional staircase to the Flushing Line Platform required to improve passenger relief along with innovative approaches such as pneumatically applied concrete to placing the final concrete liner.

The MTA C&D contracted a Design-Build (DB) team comprising of the Designer of Record (DOR), STV Inc, and the contractor, Skanska USA Civil, to perform this work. The DB selected the option to install an access shaft at the street level, followed by an access drift tunnel and finally the New Passageway.

The New Passageway consists of an East-West passageway tunnel, which is parallel to the existing subway Flushing Line platform #7 train that connects to the existing Flushing Passageway located on the Mezzanine level of the station. The North-South Passageway tunnel connects to the existing Flushing platform #7 train cavern at a predetermined location. This included the installation of an additional staircase providing passengers with an additional access point to the Flushing Line #7 train platform.

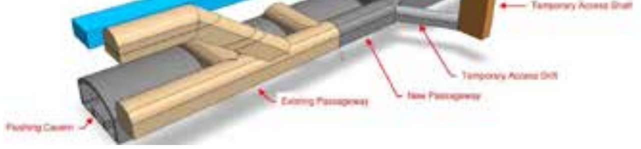


Figure 2: 3-D Rendition of the New Passageway with Existing Subway Structure; shows the project location underground in relation to the mentioned connection points within the existing subway structures

NEW PASSAGEWAY PROJECT CONTRACTUAL OBLIGATIONS

The MTA C&D team selected the following companies to perform preplanning and preparations of the procurement documents for the New Passageway at Grand Central Station: Naik Consulting Group, P.C. (project construction manager), Gall Zeidler Consultants (subconsultant tunnel engineer for station connection), Mueser Rutledge Consulting Engineers (geotechnical services), Sowinski Sullivan (architectural services), and Parsons (prime engineer).

Each entity provided their expertise and specialty, and contributed toward the project's conception, preplanning, preliminary design, procurement, and construction oversight. Subsequently, the procurement and delivery method selected for this project was design-build.

Along with the standard bidding documents, such as invitation to bidders, design-build agreement, general provisions and project requirements, design criteria, as-built/utility/survey/standard drawings, geotechnical data report, and geotechnical baseline report, the MTA's project requirement design criteria (PRDC) had to be met. The MTA's PRDC included the numerous mandatory requirements such as — scope of work, applicable codes, design and testing standards, design loads and load combinations, structure design life, pre-construction and post-construction surveys, permanent materials, concrete specifications, durability, mined tunnel excavation, initial ground support systems, initial shotcrete lining, tunnels and underground structures, subsurface investigation, ground characterization, geotechnical parameters, monitoring of instrumentation, settlement, vibration and noise, watertightness in tunnel, waterproofing system, and final concrete lining.

The successful DB team noted above was responsible for developing and providing site-specific specifications in accordance with the MTA's PRDC, enabling them to formulate and establish their final design concept and perform both the temporary and permanent works.

PLANNING THE PROJECT

The construction of a tunnel of any size in an urban environment is a task, let alone in a cosmopolitan location such as New York City. There are many variables that need to be considered — underground utilities, pedestrians, vehicular traffic, lane detours, abutters, surrounding buildings, landmark buildings, emergency access, shaft location, muck disposal, overhead crane location, and construction vehicular access to the project site.

The DB team had selected the construction site location to include the shaft point of entry, access drift tunnel, and ultimately the final location and configuration. The team preferred to use the southeast corner of Lexington Avenue and East 42nd Street to locate the access shaft (See Fig. 3).

The DB opted to install a shaft access on the southeast corner of the East 42nd Street and Lexington Avenue intersection, and the planning phase began. The project

Fig. 3: Looking southeast at the access shaft adjacent to the intersection of East 42nd Street & Lexington Avenue

shaft location is in one of busiest intersections in New York City, originally having two entrances to the MTA subway for Grand Central Station, located at the Hyatt Building and the Mobil Building Passageway.

Due to the restrictive nature of the congested urban area, Skanska was limited to a small access shaft footprint of 25 ft by 10 ft (7.6 m x 3 m) opening, of which only 125 ft^2 (12 m^2) were useable for shaft and tunnel work. The access shaft was located adjacent to the Mobil Building. The support of excavation was designed with mini piles filled with grout and rebar reinforcement, W10x112 steel walers, with 4 in. (100 mm) lagging (See Fig. 4).

EXECUTING THE PROJECT

During the planning phase, the DB determined the need to temporarily close the Mobil Passageway to subway commuters over the course of construction. The DB was only able to excavate an access shaft in a trapezoidal shape at the corner of East 42nd Street and Lexington Avenue. This shaft was constructed by conventional means of installing piles, walers and lagging to a depth of approximately 52.5 ft (16 m). The clear opening of the shaft is only 7.25 ft (2.2 m) wide by 17.5 ft (5.3 m) long, providing approximately an opening of 127 ft^2 (12 m^2) to excavate the temporary shaft, access drift tunnel followed by the full-scale excavation of the East-West and North-South Passageways (See Figs. 4 and 5).

Comparatively speaking, the surface area of the shaft opening is smaller than that of a ready-mix concrete truck. All excavation equipment, excavated muck, supplies, materials, and tunnel workers entered and exited from this relatively small opening. As the DB proceeded with tunnel excavation, they prepared themselves for the challenge of dealing with the Manhattan geology consisting of interlayered schist, gneiss, granofels, and amphibolite of the Hartland Formation with RQD values ranging from 77% - 100% with REC values from 91% - 100%.

The cross section of access drift was 11 ft (3.4 m) wide, 10 ft (3 m) high, and 39 ft (12 m) in length, and was

Fig. 4: Access Shaft Opening

excavated utilizing demolition equipment such as the Brokk with hammering tool, jack hammers, jack legs, and rock splitters. The access drift was excavated as a full-face tunnel and excavated volume was approximately 160 yd^3 (122 m^3). Installation of a lattice girder was required at both ends of the access drift, and the ground support also included an initial steel-reinforced shotcrete lining thickness of 6 in. (150 mm).

The contractor was not allowed to use explosives in New York City. Through negotiations and meetings with the Fire Department of New York City (FDNY), however, Skanska was permitted to utilize a product called NxBurst (non-electric initiation type) on a trial basis. Nxburst is a non-detonating propellant-based cartridge that can be used in locations where vibration, air-blast overpressure, and environmental sensitivities prohibit the use of explosives. The specifications were strict, with peak particle velocities limits of 1 in. per second (25 mm per second) in any of the transverse, vertical, or longitudinal directions due to close proximity of major historic buildings and public safety.

The contractor's first attempt in the access drift was deemed unsuccessful: The 4 ft round did not 'pull' the expected theoretical volume. Skanska did not see it as a

Fig. 5: Access Drift Tunnel

failure, though, but rather as a "lesson learned" for the next time. The contractor continued to excavate the access drift using mechanical demolishing tools until reaching the new passageway location at the elbow area.

The contractor began entering the new passageway through the elbow area (north-south and east-west directions). Skanska divided the tunnel excavation process into four identities: The drift extensions from the access drift, elbow area, followed by the east-west, and north-south directions (See Fig. 6).

All of these areas were performed in the traditional format: Top heading, followed by benching. The total length of the combined directions was approximately 100 ft (30 m). Upon completing the excavation for the drift extensions, Skanska proceeded to open up two concurrent top headings in the east-west and north-south directions. The project required two full-face horseshoe-shaped cross-sections. The nominal excavation cross section in the elbow area was 18.5 ft (5.6 m) wide by 15.7 ft (4.8 m) high, whereas the E-W, N-S direction was 17.2 ft (5.2 m) wide by 15.7 ft high.

The total length of the combined directions was approximately 100 ft with 975 yd^3 (745 m^3) of 'Manhattan Schist' to be removed. The specifications required ground support at 3 ft (0.9 m) or 4 ft (1.2 m) rounds with the installation of lattice girders, and twenty #9 (#29M) rebar spiles in the crown area for each lattice girder. They were also required to provide 10 in. (250 mm) of initial steel fiber

Fig. 6: Excavation of East-West Passageway (left) and North-South Passageway (right)

reinforced shotcrete to finalize the ground support system. Through mechanical means, Skanska also opted to use the Nxburst product to accelerate and improve the rock deflagration. There were three seismographs placed at different locations along the wall of the active Flushing Line #7 cavern, to verify the peak particle velocity events.

Upon completing the excavation, a 2 in. (50mm) smoothing layer of non-reinforced shotcrete was applied prior to the installation of the PVC membrane waterproofing system. The waterproofing system was comprised of geotextile fabric, PVC membrane, water barriers, and regroutable and contact grouting hoses, covering an approximate area of 4900 ft^2 (455 m^2). This was followed with the installation of typical reinforcement using #7 (#22M) rebar (See Fig. 7).

The final concrete lining was scheduled to be cast-in-place with traditional formwork, but through innovative and collaborative meetings with the MTA C&D group, PMC, and

Fig. 7: Picture shows GCS East – West New Passageway with installed PVC membrane system and reinforcement

Fig. 8: The mockup installation with the PVC membrane systems and reinforcing

Fig. 9: The progress of shotcreting through the second layer of reinforcing in the wall and arch

Skanska-STV, the shotcrete placement option was selected.

To move forward with the shotcrete option, the contractor and subcontractor were required to verify the process to ensure a quality end product. Skanska provided an important component of the process — the mockup system. The mockup system allowed Skanska to show the MTA C&D and PMC group all steps involved, such as PVC membrane installation, reinforcing bar installation, actual shotcreting placement, and quality control measures to be instituted during the shotcrete operation in the tunnel. Figs. 8 and 9 show how the PVC membrane and reinforcement would be installed, and Fig. 10 shows the results of a successful shotcreting operation. Additionally, the contractor elected to sawcut the mockup panel into multiple pieces to ensure no voids occurred during shotcreting.

Fig. 10: Shows that the PVC membrane was not damaged, as well as full consolidation of the shotcreted concrete material

Fig. 11: Patriot Shotcrete — shotcrete placement on the East-West Passageway Wall

Fig. 12: Patriot Shotcrete employee shotcreting the East-West Passageway Arch/Roof

There were two areas of concern to be evaluated: Damage of the PVC membrane after shotcreting, and voids around the reinforcement. Upon reviewing the process exhibited during mockup system and observing the successful results, the project team proceeded with the shotcreting process in the New Passageway Tunnels with Skanska and their subcontractor Patriot Shotcrete, after they successfully alleviated these concerns. Figs. 11 and 12 show the shotcrete application of a typical wall and arch/roof, with the final opening of the Grand Central Station New Passageway in Fig. 13.

Conclusion

Construction of a tunnel is demanding, and adding the urban environment variable makes it an even more challenging endeavor. This project with its design-build format was fortunate to have forged a teamwork mentality from the onset of construction, with collaboration and determination. Many thanks to MTA C&D, design-builder STV-Skanska with Patriot Shotcrete, PMC team of Naik Group, subconsultants Parsons, and GZ Consultants. With this exemplary team, the project was a great success.

2025 OUTSTANDING UNDERGROUND PROJECT

Project:
NYC Grand Central Station New Passageway

Project Location:
New York City, NY

Shotcrete Contractor Company:
Patriot Shotcrete*

Engineer Company:
STV Incorporated

Materials Supplier Company:
Tec-Crete Transit Mix

General Contractor:
Skanska USA Civil Northeast

Additional Team Members:
Naik Consulting Group

Owner:
Metropolitan Transit Authority

*ASA Sustaining Corporate or Corporate Member

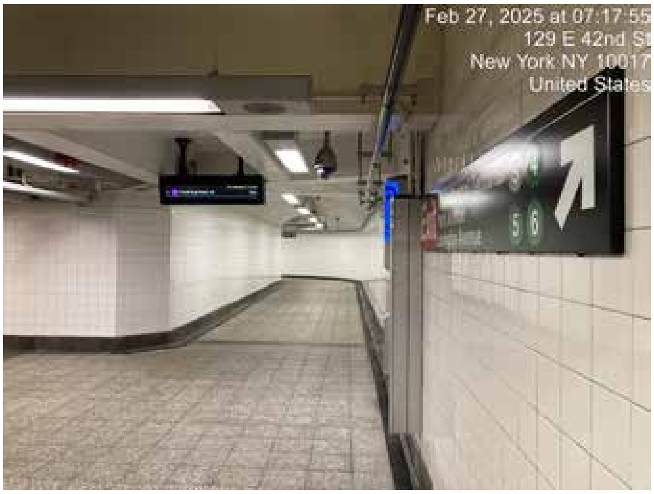


Fig. 13: A view of the finished East-West New Passageway in Grand Central Station

Louis Falco *is a Senior Tunnel Engineer, Senior Project Manager with Gall Zeidler Consultants, a global specialty tunneling and underground engineering firm. Louis graduated from Concordia University (Montreal, Canada) with a Bachelor of Engineering (Civil). With more than 45 years of experience, he has worked in various fields such as structural design, major falseworks (Place des Martyrs [Algiers]), concrete design, support of excavations, tunneling and underground engineering (eg. Montreal South Shore, Austin Govalle Tunnel, Boston Central Artery, Chicago TARP, Milwaukee MMSD, Cleveland NEORSD), manufacturing precast concrete segmental tunnel liners for major projects (e.g., CBBT, REM, NEORSD, RONDOUT, BSIT, LAX), and construction management with major contractors on various heavy construction projects both above ground and underground (SA Healy, Kiewit, Perini, Atlas, Impregilo, Kajima) in Canada, the U.S., and Africa. Louis is also a member of the GZ Subject Matter Expert team for the VTA BSVII project, recently completed the Grand Central Station New Passageway in New York City, and is now assigned to the PMC team on the Second Avenue Subway Phase 2 in New York City. Member of the American Society of Civil Engineers, Disputes Review Board Foundation, ITA Working Group 12 - Sprayed Concrete, Underground Construction Association (UCA of SME), and lead author contributing to the Handbook of Precast Segmental Tunnel Lining Systems. He is also the Vice Chair of the North American Tunneling Planning Committee.*

2025 Outstanding Rehabilitation & Repair Project

From Legacy to Longevity

THE ABITIBI CANYON DAM REHABILITATION PROJECT

By Eve-Lyne Sylvestre, André Corbin, and François Gagnon

PROJECT BACKGROUND

The rehabilitation of the Abitibi Canyon Dam marks a defining moment in the renewal of Canada's hydroelectric infrastructure. Constructed between 1930 and 1936, the 150 ft (46 m) high structure continues to deliver 349 MW of clean energy to Ontario, standing not only as one of the province's tallest dams but also as a lasting testament to early 20th-century engineering excellence. Located within the traditional territories of the Cree and Anishinaabe communities, the project carries profound cultural significance, underscoring the shared responsibility of ensuring sustainable development for future generations.

The dam owner's decision to rehabilitate the downstream west gravity bulkhead face was far more than a standard maintenance initiative; it also extended the service life of the dam's downstream concrete walls. These structures exhibited progressive surface scaling, spalling, cracking, staining, and delamination (Fig. 1). The repair surface presented a complex challenge due to restricted access and varying angles. The rehabilitation was performed using dry-mix shotcrete over the summer of 2025.

WHY DRY-MIX SHOTCRETE?

Conventional concrete repair methods would have required extensive formwork (significantly raising cost) and logistical complexity, stretching the schedule. In addition, the remote location in northeastern Ontario placed the nearest concrete plant over 93 mi (150 km) away. To overcome these constraints, the project team from Peter Kiewit Sons ULC proposed an innovative alternative: Dry-mix shotcrete. This strategic shift enhanced feasibility, eliminated the need for mobilizing a batch plant for a relatively small volume of concrete, accelerated project delivery, and reduced costs, all while ensuring completion before winter. The dry-mix shotcrete approach also delivered unmatched flexibility, allowing 'stop and go' operations without material loss or cold joint issues — an invaluable advantage in a remote, weather dependent environment. Moreover, it was ideally suited to the site's access constraints, space limitations, and varying surface angles.

Fig. 1: Downstream face of the dam prior to rehabilitation, showing the scale of deterioration and the challenge of preserving one of Ontario's tallest hydroelectric landmarks

SCOPE OF WORK AND COLLABORATION

The rehabilitated portion of the downstream west gravity bulkhead face measured approximately 82 ft (25 m) high and 165 ft (50 m) wide. The area included slopes of 9:12 and 6:12, a vertical face, and an overhead section with a cantilever (not shown in the layout) that required thick multilayer placement (Fig. 2). The surface preparation commenced with removal of all damaged concrete, followed by erection of a scaffold system adaptable to changing surface angles (Fig. 3). FlexoDrain systems were installed on the surface prior to shotcrete placement to manage water infiltration under the future surface. Over 8000 dowels were drilled and fixed with epoxy resin, and wire mesh was affixed to lie 4 in. (100 mm) beneath the target finished surface (Fig. 4). After these steps, quality trials were executed to qualify the shotcrete mixture, shotcreters, equipment, and validate the finished surface with the client (Fig. 5).

At the heart of the project was exemplary collaboration among all parties. Kiewit led project coordination and alignment across disciplines from site preparation through completion. SWATcrete directed the technical execution, introduced customized equipment to boost productivity, and engaged trusted partners to optimize the three key factors affecting shotcrete quality: Shotcreters, concrete materials, and equipment. SWATcrete engaged L. Fournier & Fils Inc. to supply a robust dry concrete mixture in 4850 lb (2200 kg) bulk bags, MAH Béton Projeté to deliver skilled labor for precision placement, and EVO Matériaux to provide quality control, technical support, and consistency across every project phase.

Project specifications were drafted by Atkinsréalis in accordance with ACI 506.2 and CSA A23.1 24. The mixture

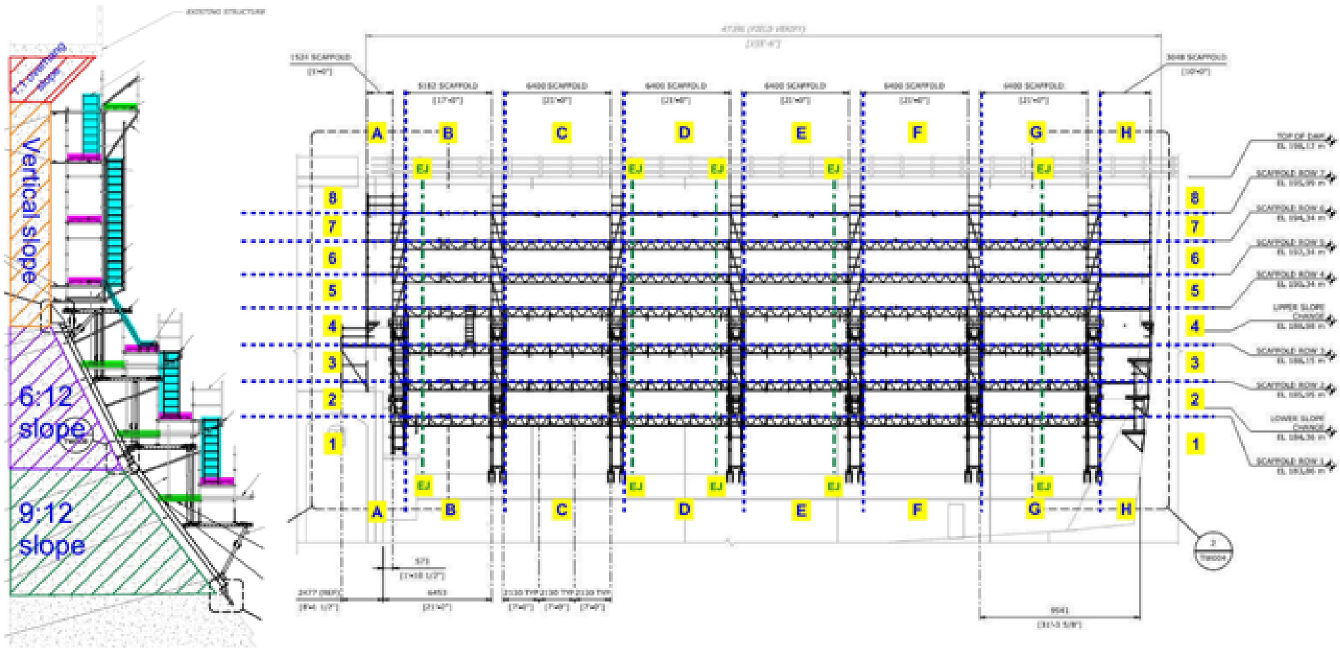


Fig. 2: Dam Grid Division — An elevation view of a scaffold system covering multiple dam slopes, emphasizing scope and complexity of access planning

Fig. 3: Full scaffold system in place, adaptable to the surface variating angles, designed to provide safe access and precise working platforms for shotcrete placement

Fig. 4: Dowels and wire mesh installation in preparation for shotcrete placement

was required to achieve a minimum 28-day compressive strength of 4400 psi (30 MPa), an air void system of ≤300 μm (ASTM C457), and a minimum air content of 3% to ensure freeze-thaw resistance. Synthetic microfibers were also added to minimize plastic shrinkage cracking.

Approximately 312 bulk bags were used for the project. In total, 315 yd^3 (240 m^3) of concrete were shotcreted and finished, excluding rebound, finishing cuts, and daily test panels. Thicknesses ranged from 8 to 20 in. (200 to 500 mm) in multilayer application across a surface area exceeding 10,000 ft^2 (930 m^2). The surface was finished with wood trowels to preserve the air void system and maintain freeze-thaw durability. A chemical cure was subsequently applied to the finished surface.

Fig. 5: Trial setup with varied shooting angles to optimize technique and validate dry-mix adaptability before full application

Fig. 6: Loading the customized Aliva 252 dry-mix gun with bulk bags at dam crest, enabling efficient placement and high productivity in a complex environment

Fig. 7: Right section fully shot, leveled, and finished; left section awaiting final layer — showcases controlled, step-by-step methodology

TECHNICAL CHALLENGES AND EXECUTION STRATEGIES

To maximize production rate, an Aliva 252 dry-mix gun — with customized addons by SWATcrete — was deployed. The gun featured a hopper tailored to receive the dry concrete material from the bulk bags without chutes. There was also an internal knife system that opened the bulk bags automatically with only a telehandler required. The installation was protected from rain and wind by a structure erected over the dry-mix gun (Fig. 6).

The concrete mixture provided by L. Fournier & Fils Inc. was the 1220-5160 HQ Series. A non-accelerated formulation was deliberately chosen to allow consistent surface finishing before the initial set, which occurred approximately three hours after application (Fig. 7). To offset the absence of an accelerator and ensure strong adhesion, the shotcrete was applied in multilayer passes, particularly in overhead sections where the thickness of a layer remained between 2 and 4 in. (50 to 100 mm). Piano wires were installed to align with previously finished areas, serving as guides to accurately trim excess material prior to final surface finishing. While water curing using geotextiles would have offered optimal crack prevention, it was impractical on the vertical, inclined, and overhead surfaces with limited access; thus a spray-on curing membrane was selected as the pragmatic and efficient solution.

Protecting adjacent structures from rebound and overspray posed a major challenge. Without adequate protection, cleanup — particularly of wire mesh — would have been labor-intensive and time consuming, as residual shotcrete material could hinder proper encapsulation (Fig. 8). Protection and cleanup of each section were integrated efficiently in the daily coordination.

Precise sequencing and coordination of all teams were essential to synchronize each stage (Figs. 9 & 10). This project was a demanding undertaking that required creative solutions, technical mastery, and close collaboration. Beyond individual achievements, the partnership thrived on clear communication, adaptability, and a unified commitment to excellence. Challenges were met as one team; lessons were applied in real time, and incremental innovations emerged through shared endeavour. The result was not only a technically exemplary rehabilitation but also a model of collaborative success — one that strengthened expertise, forged relationships, and established a new benchmark for complex hydroelectric infrastructure renewal (Figs. 11 & 12).

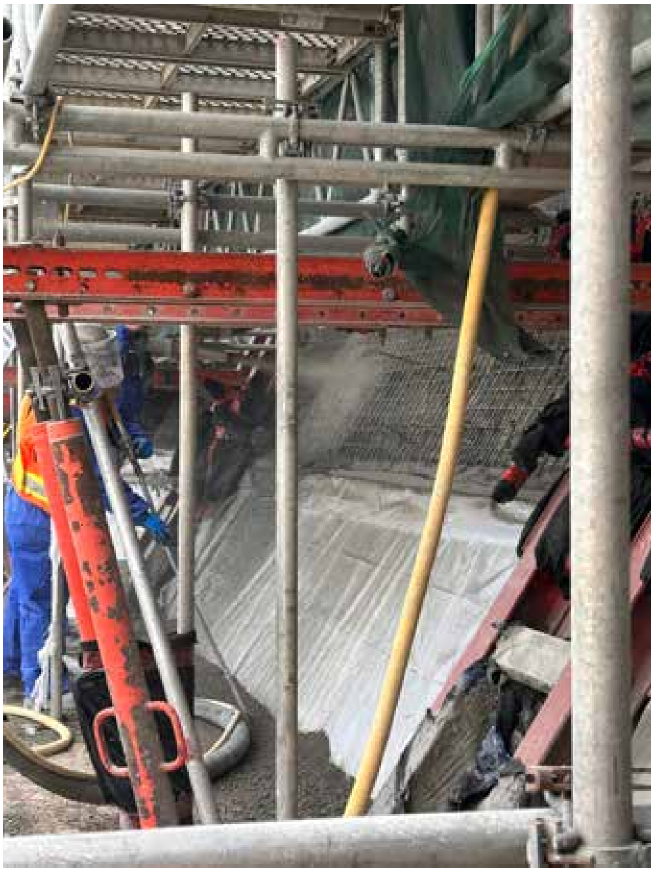


Fig. 8: Image illustrates restricted scaffold access during placement, finished surface protection, and second layer application

Fig. 9: Shotcreter operating from manlift on cantilever section, supported by scaffold crews preparing, cleaning, and removing protections below — demonstrates teamwork and coordinated trades

Fig. 10: Shotcreter operating from manlift on cantilever section, supported by scaffold crews preparing, cleaning, and removing protections below — demonstrates teamwork and coordinated trades (view from another angle)

Fig. 11: Newly restored downstream surface revealed during scaffold removal, highlighting uniform quality and precision in application

Fig. 12: CENTER: Dry-mix shotcrete rehabilitation; LEFT: Conventional concrete rehabilitation; RIGHT: Unrepaired section — clear visual contrast demonstrates the effectiveness of the chosen method

2025 OUTSTANDING REHABILITATION & REPAIR PROJECT

Project:
Abitibi Canyon Z7 Dam Rehabilitation

Project Location:
Abitibi Canyon, ON, Canada

Shotcrete Contractor Company:
SWATcrete*

Architect Company:
Atkins Realis

Engineer Company:
Atkins Realis

Materials Supplier Company:
L. Fournier & Fils Inc*

Equipment Manufacturer Company:
SWATcrete* (Customized Aliva 252)

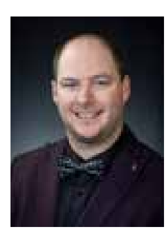
General Contractor:
PETER KIEWIT SONS ULC

Additional Team Members:
MAH Béton Projeté / Evo Matériaux

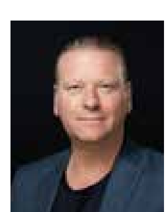
Owner:
Ontario Power Generation

*ASA Sustaining Corporate or Corporate Member

***Eve-Lyne Sylvestre**, Ph.D., is the Director of Quality, Product Innovations, and Environment at L. Fournier & Fils Inc. With 15 years of experience in the industry, she specializes in developing innovative concrete and shotcrete solutions tailored to diverse project needs. Her work focuses on combining technical performance with environmental preservation, supporting both fixed and mobile operations, particularly in northern and remote areas.*



***André Corbin**, Eng. Civil Engineering, began his career at Kiewit working on a hydroelectric project; a field which has remained central to his expertise over 17 years of service. Now a Project Manager, André has led a wide range of infrastructure projects, including several major hydroelectric developments. Aligned with Kiewit's culture of innovation, he is committed to mobilizing top resources and exploring new approaches to deliver high-quality solutions to clients.*



***François Gagnon** has over 35 years of experience in underground mining operations, and brings deep expertise in the application of cement-based products, including dry-mix shotcrete, as well as the logistics and operational complexities these projects involve. His career has been shaped by challenging work in northern, remote, and underground environments, where precision, adaptability, and innovation are key to success.*

2025 Outstanding Infrastructure Project

Humber College Station Shotcrete Construction

DESIGN, SUSTAINABILITY, AND EXECUTION

By Ross King

Humber College Station is located at the west end of the 6.4 mi (10.3 km) Finch West LRT, which includes 16 stops and two below-grade terminal stations. The Humber College Station is constructed below grade, however open to daylight, which presented unique logistical, structural, and architectural challenges. Two roadway bridges were installed prior to station construction, requiring all work to be completed beneath active bridges carrying live traffic overhead. These conditions, combined with demanding architectural requirements and an aggressive winter construction schedule, made shotcrete the optimal construction solution.

The station measures approximately 50 ft (15 m) wide, 30 ft (9 m) deep, and 550 ft (170 m) long. The vertical shotcrete walls reach a thickness of up to 5 ft (1.5 m) and were designed to meet both demanding structural requirements and strict architectural expectations. The architectural design called for a smooth, high-quality finish with continuous 4 in. (100 mm) triangular vertical reveals spaced at 4 ft (1.2 m) on center and a 1:50 batter, creating a precise and visually prominent surface.

To accommodate the soil retention anchors, the walls were constructed in three lifts. This sequencing allowed for the anchors to be de-tensioned once the

Finished shotcrete wall at Humber College Station

Interior 5 ft. thick wall with keyway and water stop

Top of wall angle iron gauge and revels

Finished walls; three-lift-tall walls with controlled construction joints to replicate a formed concrete seam.

lower lift achieved design strength. The lift lines between placements were required to closely replicate a formed concrete joint, similar to the seam between two sheets of plywood in a form-and-pour wall — an uncommon and highly demanding requirement for shotcrete construction, particularly in an open-to-daylight station where joints are visible in direct sunlight.

The designer specified a low-heat concrete mixture to enhance the durability and minimize the risk of thermal cracking, a critical consideration given the wall thicknesses and constrained geometry. The project schedule was extremely demanding and required continuous shotcrete operation throughout the winter, with temperatures reaching 0°F (-18°C), placing an additional emphasis on thermal control plans, curing practices, and quality control.

Sustainability played a key role in the material selection, and construction methodology. A high-slag, low-cement concrete mixture was used to help meet the project's sustainability targets by reducing cement content and thus lowering the embodied carbon of the structure. In addition, the shotcrete placement and finishing methods produced a denser troweled surface than conventional form-and-pour concrete, increasing durability and extending the overall life cycle of the structure.

The elimination of formwork further reduced the environmental impact by lowering the material consumption, minimizing the trucking to and from the site, and reducing the time spent for erecting wall forms. These sustainability benefits were matched by significant schedule savings, as shotcrete placement eliminated the requirement to leave formwork in place for a seven-day curing period. Under a conventional form-and-pour system, formwork must remain in place during curing, preventing stripping, cycling, handling, and storage. These activities typically require large crews and extensive crane time, which can become critical bottlenecks on constrained transit projects. By using shotcrete placement, these constraints were substantially reduced, allowing the project to maintain momentum despite challenging site and weather conditions.

The elimination of wall formwork also removed the need for a dedicated tower crane on the project. Instead, a small mobile crane was deployed to lower reinforcing bar and scaffold components into the excavation. This substitution eliminated the installation and dismantling of a tower crane and reduced overall crane time to short-duration lifts, resulting in a significant reduction in crane hours, fuel consumption, and associated emissions. The mobile crane approach also reduced site congestion and avoided the continuous crane dependency typically associated with form-and-pour construction. Overall, this strategy improved operational flexibility, reduced costs, and minimized logistical constraints.

The use of shotcrete enabled works on the central platform slab to be performed simultaneously with the station wall construction. The elimination of A-frame and conventional wall formwork kept the slab unobstructed, allowing reinforcing bar installation, formwork, and concrete placement to proceed in parallel with wall operations. Under a traditional form-and-pour approach, A-frame forms would have occupied critical workspace, forcing platform slab construction to occur sequentially and extending the overall schedule. By removing these physical constraints, the shotcrete methodology allowed critical path activities to be performed simultaneously, providing significant schedule benefit to the project.

The complexity of the Humber College Station walls further reinforced why structural shotcrete was the right construction method choice. The combination of height, thickness, and highly congested, large 5-layered reinforcing steel required a placement approach capable of achieving full consolidation and encapsulation of the rebar. The specifically designed concrete mixture was paired with the supplemental internal vibration when required, which was intermittently vibrated at every bench to ensure proper encapsulation of the reinforcement bars and to maintain consistent density throughout the wall section.

Maintaining the architectural continuity between the three lifts was critical. An angle-iron gauge line was installed to establish a straight, flat, and consistent top-of-wall edge, allowing the subequal lifts to align precisely with the lower lift. This approach effectively concealed the horizontal

Mobile crane replacing tower crane by using shotcrete placement instead of a form-and-pour approach

Multi-level scaffold provided access for the shotcreter to shoot the walls, and for the crew to blowpipe, vibrate, and finish

construction joint and gave the appearance of a continuous, formed concrete wall — an especially important detail, given the station's exposure to natural light.

The architectural reveals presented another significant technical requirement. The specified 4-inch-wide by 2.5-inch (64-millimeter) deep triangular reveals could not be reliably hand-cut into the finished concrete without risking aggregate pullout or irregular edges. To achieve the required precision, the reveals were pre-hung prior to shooting, allowing the shotcrete to be fully consolidated behind them. This method produced crisp, straight reveal lines while maintaining the surface integrity and finish quality.

The flexibility of structural shotcrete placement also allowed for the wall thicknesses to be easily adjusted at the top of the structure to create thinner parapet walls, internal haunches, and bearing seats for the steel structures above, without redesigning or constructing formwork.

Finally, the high-quality troweled finish eliminated the need for secondary rendering or surface treatments, providing additional schedule and cost efficiencies, while meeting the project's architectural durability requirements.

Prior to commencing any shotcrete work at Humber College Station, a full-scale preconstruction mock-up was required. This panel was shot under site-specific conditions to demonstrate that the proposed concrete mixture, equipment, and application methods would achieve full consolidation around the reinforcing steel with no shadowing or voids. The mock-up also served to confirm that shotcrete was a suitable construction method for the project, meeting both the structural and quality requirements. Successful completion and review of the preconstruction mock-up provided assurance that the specified reinforcement coverage, encasement, bond, and overall performance could be reliably achieved in the field.

Humber College Station demonstrates how thoughtful structural shotcrete design, innovative placement methods, and sustainable material choices can successfully meet the needs of the complex architectural, structural, and environmental requirements of a large-scale transit infrastructure project. This project illustrates that shotcrete was not only a viable solution, but the optimal choice — delivering durability, precision, adaptability, and schedule savings within a highly constrained urban environment.

Preconstruction mock-up wall

2025 OUTSTANDING INFRASTRUCTURE PROJECT

Project:
Humber College Station

Project Location:
Toronto, ON, Canada

Shotcrete Contractor Company:
Consolidated Shotcrete Inc.*

Architect Company:
Arup

Engineer Company:
Arup

Materials Supplier Company:
Dufferin Concrete

Equipment Manufacturer Company:
Western Shotcrete Equipment*

General Contractor:
Mosaic Transit Group Joint Venture (Aecon Infrastructure and Management Inc., Dragados Canada Inc., Dufferin Construction Company)

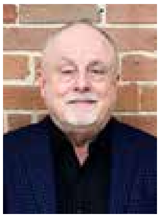
Additional Team Members:
Avenue Building Corp; Wood; LZhang Consulting & Testing Ltd

Owner:
Metrolinx

*ASA Sustaining Corporate or Corporate Member

Completed shotcreted mock-up wall to be cut with a diamond saw into sections to inspect for full consolidation and encapsulation of reinforcing steel

Cut-out section of shotcreted wall demonstrating proper consolidation and full encapsulation of reinforcing steel, including keyway and water stop



***Ross King**, President of Consolidated Shotcrete, is widely regarded as a pioneer in establishing the shotcrete industry in Canada. With more than four decades of experience, his leadership has set benchmarks for quality, innovation, and safety across major infrastructure and heavy concrete projects. Under his guidance, Consolidated Shotcrete has grown into a national leader in shotcrete and comprehensive concrete solutions.*

2025 Outstanding New Construction Project

Lower retaining wall placed with shotcrete, followed by hand-sculpted dimensional stone detailing to integrate structural performance with natural aesthetics

Point Grey Foreshore

COASTAL STABILIZATION THROUGH SHOTCRETE INNOVATION

By Dan Pitts

Perched high above the Pacific, the Point Grey Foreshore stabilization project presented a rare convergence of coastal engineering, structural complexity, and architectural artistry. Rising approximately 45 ft (14 m) above sea level, the site demanded a solution capable of withstanding marine exposure, challenging access, and complex geometry, while also delivering a finished surface that blended seamlessly with its dramatic surroundings. Shotcrete proved to be the ideal answer.

Completed by Ocean Rock Art Ltd, the project showcases how advanced shotcrete techniques can merge structural performance with sculpted architectural expression, resulting in a stabilization system that is both resilient and visually compelling.

ENGINEERING AGAINST THE TIDE

One of the defining challenges of the project was the tidal environment. Structural shotcrete placement had to be carefully coordinated with tide cycles to ensure optimal conditions for bonding, curing, and long-term durability. Crews timed their operations precisely, shooting the structural elements during favorable tidal windows to minimize exposure to wave action and water intrusion.

This approach allowed Ocean Rock Art to create a monolithic, reinforced structural concrete shell that tied directly into the hillside while resisting the dynamic forces of the coastal setting. Shotcrete placement's ability to be applied vertically and overhead — without traditional formwork — was critical in maintaining efficiency and safety in such a demanding environment.

PUMPING DISTANCE AND SITE ACCESS

With limited access at the top of the bluff, material delivery posed another significant hurdle. Shotcrete was pumped approximately 275 ft (84 m) from the staging area to the point of placement. This distance highlighted one of shotcrete's most valuable advantages: Its ability to maintain consistency, workability, and structural integrity over long pump runs without segregation or performance loss.

The pumping setup minimized site disruption, eliminated the need for heavy lifting equipment, and allowed continuous placement in an otherwise difficult-to-reach coastal location.

CURVED GEOMETRY AND STRUCTURAL FREEDOM

The project's sweeping curved retaining wall is both a structural necessity and a defining architectural feature. Traditional form-and-pour concrete would have required extensive, highly customized formwork to achieve the radius and integrated details. Shotcrete placement removed those constraints entirely.

By applying material directly to the reinforcing steel, Ocean Rock Art shaped the wall organically to follow the site's natural contours. This formwork-free approach allowed for continuous curvature, uniform structural thickness, and seamless transitions, demonstrating why shotcrete placement is especially well-suited for complex geometries.

DECORATIVE SHOTCRETE AND ACCELERATED SCULPTING

Following structural placement, the project transitioned into its architectural phase. Decorative carve-grade concrete was applied using an accelerator atomizer at the shotcrete nozzle, enabling rapid set times below the tide line and immediate sculpting. This technique was especially

Floating stair system constructed in shotcrete and finished with sandstone textures, creating a seamless transition between structure and landscape

Custom sandstone-style shotcrete sculpture carved to replicate natural stone formations while maintaining engineered durability

Completed shotcrete stairs and columns demonstrating consistent texture, form accuracy, and structural integration important for overhead surfaces, where traditional finishing methods would have been impractical.

The lower portion of the wall was shot monolithically and then sculpted to evoke an old English castle-inspired, dimensional rock placement, including a curved turret that adds depth and character. The upper wall section was sculpted to mimic a west coast sandstone cliff. All stairs, risers, and treads were sculpted entirely from concrete, integrating structural durability with hand-carved detail.

Multi-stage coloring process applied to shotcrete surfaces to achieve realistic stone tones and depth

Steel reinforcement and formwork in place prior to shotcrete placement, ensuring structural integrity and long-term performance

FLOATING STAIRCASE AND OVERHEAD APPLICATION

A signature element of the project is the floating staircase, which was formed and poured and then sculpted once stripped. Shotcrete placement's exceptional overhead adhesion, accompanied with the use of accelerator atomizer, allowed full reinforcement encapsulation and fast sculpting while eliminating the need for complex underside form liners.

Once placed, the staircase was carved to resemble naturally weathered, west coast-manufactured granite block with layered color textures, softened edges, and organic variation that reflect the coastal geology of the region.

THE WEST COAST SANDSTONE FINISH

Throughout the project, the larger finished shotcrete surfaces were sculpted to replicate the look of west coast sandstone, rather than traditional masonry or quarried stone. This aesthetic choice grounds the structure in its natural environment, allowing the stabilization wall, landings, and architectural elements to appear as if shaped by the coastline itself.

The result is a cohesive visual language — rugged, timeless, and unmistakably coastal — achieved entirely through sculpted shotcrete.

A LASTING COASTAL STATEMENT

The completed stabilization wall stands as both an engineered solution and a sculpted architectural feature. Through precise timing, technical expertise, and artistic craftsmanship, Ocean Rock Art delivered a project that stabilizes the coastline while enhancing its visual presence.

By harnessing the full potential of shotcrete placement, the Point Grey Foreshore stabilization demonstrates how modern concrete techniques can protect, shape, and elevate coastal environments, creating structures that are as enduring as they are expressive.

Engineered scaffolding system installed to provide safe access for shotcrete application and sculpting in a challenging shoreline environment

Why Shotcrete Was the Right Choice

Shotcrete provided critical advantages for the Point Grey Foreshore project:

- Formwork-free construction for complex curves and vertical surfaces
- High bond strength, ideal for coastal stabilization
- Reliable pumping over long distances of approximately 275 ft
- Accelerated set times enabling immediate carving and detailing
- Seamless integration of structural and decorative concrete

Overhead shotcrete application beneath stair structure, showcasing precision placement in confined and elevated conditions

2025 OUTSTANDING NEW CONSTRUCTION PROJECT

Project:
Point Grey Shoreline Stability

Project Location:
Vancouver, BC, Canada

Shotcrete Contractor Company:
Ocean Rock Art LTD*

Architect Company:
Paul Sangha Creative

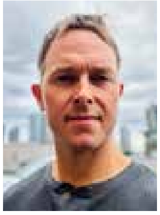
Materials Supplier Company:
Heidelburg Materials

Equipment Manufacturer Company:
Putzmeister*

General Contractor
GWilson Construction

Owner:
Claire and Jaime Wright

**ASA Sustaining Corporate or Corporate Member*



Dan Pitts *is President of Ocean Rock Art Ltd. and Partner in Ocean Rock Art US LLC. He is an ACI Certified shotcreter and proudly serves as a sustaining corporate member of the American Shotcrete Association. Ocean Rock Art's work has garnered widespread recognition, earning multiple accolades. Dan Pitts's innovative approach to blending nature with design sets him apart as a true luminary in the field of shotcrete rock art, leaving an enduring mark on the landscape of contemporary architecture.*

2025 Outstanding International Project

How Zolula is Redefining Large-Scale Slope Stabilization in South Africa

By Adriaan Havenga

In the rugged terrain between Grahamstown and the Fish River Pass, where steep cuttings slice through unforgiving rock formations, engineering precision is not a luxury — it is a necessity. Along this demanding stretch of the National Route N2, Zolula (Pty) Ltd has quietly delivered one of the largest and most technically advanced slope stabilization projects South Africa has seen.

Over two years, across remote and mountainous Eastern Cape landscapes, Zolula executed an immense lateral support scope involving 39,000 m^2 (420,000 ft^2) of shotcrete, 14,000 m^2 (150,000 ft^2) of mesh drapery, and nearly 9000 rock anchors — all while coordinating with earthworks, blasting, and road construction teams under tight sequencing constraints.

What emerged is not just a stabilized road corridor, but a benchmark for modern slope stabilization in Africa.

Rock anchor installation Cutting 6: Bench 2

Bulk excavation for final bench Cuttings 6 & 4

A ROAD REIMAGINED

The N2 upgrade between Grahamstown and the Fish River Pass forms part of a broader national effort to improve safety, capacity, and long-term resilience along one of South Africa's most important transport arteries. The project required significant horizontal and vertical realignment of the road, forcing excavation through steep, geologically complex terrain.

Three major cuttings were identified as high-risk zones — areas where traditional slope treatments would not provide sufficient long-term stability or durability. Instead, the design called for modern, low-maintenance slope stabilization systems capable of performing over decades with minimal intervention.

Zolula was appointed as the specialist lateral support contractor, tasked with delivering solutions that balanced safety, constructability, sustainability, and scale.

ENGINEERING THE SLOPES: DESIGN WITH INTENT

The stabilization strategy divided each cutting into two distinct zones — each engineered to respond to its unique risk profile.

UPPER SLOPES: CONTROLLED DRAPERY

The upper portions of the cuttings were designed at a 1:1.5 slope, stabilized using mesh drapery systems pinned by 3 m (10 ft) rock anchors. These anchors were installed in rows, with 16 mm (0.63 in.) anchor cables tensioned to create a continuous stabilizing network over the rock face. The mesh was then progressively rolled down the slope, secured with galvanized plates and nuts at each anchor row.

This approach allows controlled movement of small rock fragments while preventing larger failures — an ideal solution for weathered rock zones prone to ravelling.

LOWER SLOPES: STRUCTURAL SHOTCRETE

Below, the geometry steepened dramatically to 1:0.7 (approximately 80°). Here, stability demands were far higher. The solution combined:

- 3 m, 6 m, and 9 m (10 ft, 20 ft, and 30 ft) rock anchors
- Reference 395 welded reinforcing mesh
- 100 mm (4 in.) thick wet-mix shotcrete layers

The result was a reinforced structural façade that not only stabilized the cut face but also protected the road from rockfall impacts originating higher up the slope.

Separating the two systems was a 3 m wide summit drain, finished either in shotcrete or stone pitching depending on access constraints — a critical detail in managing long-term water control.

WATER: THE SILENT ENEMY

In slope engineering, water is often the most destructive force. Recognizing this, the design incorporated aggressive drainage measures throughout.

Two rows of 20 m (66 ft) drainage adits, drilled at a 10° upward inclination, were installed to relieve water pressure trapped within the rock mass. These were complemented by geotextile band drains positioned at 45° behind the shotcrete face, leading to weep holes that allow controlled


Lateral support on Cuttings 4, 5, & 6 nearing completion

discharge of groundwater.

The emphasis on drainage ensures that the stabilization system remains effective long after construction crews have left the site.

BUILT FROM THE TOP DOWN: PRECISION IN SEQUENCE

Construction followed a disciplined top-down benching methodology, advancing in 2.5 m (8.2 ft) vertical increments. Each stage required seamless coordination between drilling, blasting, earthworks, mesh installation, anchoring, and shotcrete application.

Shotcrete operations were critical to maintaining momentum. Once applied, areas could typically achieve 70% of design strength within two working days, allowing crews to safely drop to the next bench without delaying adjacent activities.

The shotcrete placement followed a meticulous sequence:

1. Rock face cleaning using compressed air
2. Anchor installation via DTH drilling with 30 MPa (4300 psi) grout
3. Drain installation
4. First 50 mm (2 in.) of 25 MPa (3600 psi) wet-mix shotcrete layer
5. Installation of reinforcing mesh and load-distribution spiders
6. Final 50 mm shotcrete layer with nozzle finish

All shotcrete was placed using two Putzmeister P718 TD pumps, operating over hose lengths exceeding 100 m (330 ft) and elevation differences greater than 10 m (33 ft) — a testament to both equipment reliability and crew expertise.

SCALE BY THE NUMBERS

By completion, the project delivered quantities rarely seen in South African slope stabilization:

- 39,000 m² of shotcrete
- 14,000 m² of mesh drapery
- 6900 3 m anchors
- 950 6 m anchors
- 350 9 m anchors
- 525 drainage adits

All steel components were hot-dip galvanized, ensuring long-term corrosion resistance in harsh environmental conditions.

SUSTAINABILITY IN PRACTICE

Beyond structural performance, the project stands out for its pragmatic sustainability.

All shotcrete was batched on site using a Karoo batch plant, with aggregates sourced from quarries within a 100 km (62 mi) radius. This significantly reduced trucking requirements, fuel consumption, and CO_2 emissions when compared to conventional ready-mix supply chains.

Equally important is longevity. Shotcrete systems, when correctly designed and installed, require minimal maintenance over their lifespan — reducing future disruption, repair costs, and environmental impact.

CHALLENGES THAT DEFINED THE OUTCOME

The project was not without its complexities. Working in a remote area demanded logistical precision. Limited access meant creative pumping solutions, extended hose runs, and constant coordination with blasting and earthworks teams. These constraints essentially became proving grounds for us — reinforcing the value of experience, adaptability, and planning.

As one observer noted, this was “quality infrastructure delivered at a scale rarely seen before in South Africa.”

BEYOND CONCRETE: BUILDING COMMUNITIES

While the engineering achievements are tangible, the human impact is equally significant.

The project employed more than 50 local workers, providing skills transfer and economic upliftment in a rural region where such opportunities are scarce. Exposure to modern slope stabilization techniques has left a lasting

2025 OUTSTANDING INTERNATIONAL PROJECT

Project:
National Route N2 Slope Stabilization

Project Location:
Eastern Cape, South Africa

Shotcrete Contractor Company:
Zolula (Pty) Ltd*

Architect Company:
Bosch Projects

Engineer Company:
AGES-Group

Materials Supplier Company:
WBHO Construction

Equipment Manufacturer Company:
Putzmeister*

General Contractor:
WBHO Construction

Additional Team Members:
Civils2000

Owner:
South African National Roads Agency SOC Ltd

**ASA Sustaining Corporate or Corporate Member*

legacy — one that extends well beyond the road itself.

A BLUEPRINT FOR THE FUTURE

The N2 slope stabilization project stands apart in Zolula's experience — not just for its size, but for what it represents. It is proof that:

- Large-scale infrastructure can be delivered sustainably.
- Specialist engineering can thrive in remote conditions.
- Local communities can benefit meaningfully from major projects.

And perhaps most importantly, it demonstrates that South African geotechnical expertise is capable of world-class execution.

In an industry where success is often buried beneath the surface, Zolula's work on the N2 ensures that stability, quite literally, stands the test of time.

Adriaan Havenga *is the Managing Director and Founder of Zolula (Pty) Ltd, an industry-leading specialist geotechnical contractor in South Africa. With 17 years of experience, he is known for delivering relationship-driven solutions, guided by a future-focused mission to be the partner of choice for all geotechnical solutions across South Africa. Zolula has grown into a relationship-driven, technically focused contractor known for delivering in challenging environments. Supported by a compact leadership team and industry leading equipment, the company operates with the agility of a specialist and the capability of a major player. Zolula's B-BBEE Level 2 status further positions it as a preferred partner on both public and private sector projects across Southern Africa.*

2025 Outstanding Pool & Recreational Project

Finished pool

Southern Living Pools

YATES PROJECT

By Juanjose Armenta-Aguirre

The phone rings: "Junior, come bring us a truck."

This is nothing out of the ordinary for me. I drive a truck when needed, and that call was no exception, especially with the jobsite out in the Marble Falls/Horseshoe Bay area of Central Texas. Considering the time of day, I would be the last truck arriving and would have to bring an empty truck back — this way the crew wouldn't have to wait for material.

I arrived and got off the truck, but before I had a chance to prep it, Trent Dalton (Field Supervisor for Southern Living Pools) came up from behind me and put his hand on my shoulder. "Junior, you got a minute? I want to show you something."

I followed him in a pickup truck to a spot in the Escondido Lago gated community of Horseshoe Bay. After we arrived, Dalton asked me, "What do you see?"

Very confused, I offered: "Well, I see beautiful homes and the lake."

"What's missing?"

"Let me guess, a pool?" I was being humorous.

"Exactly!" Then Dalton talked with me about a new project they had just acquired, and we began to plan for something that neither one of us had done, either in size or location.

This residential project of Southern Living Pools is located on Apache Tears Road in the gated community of Escondido Lago. The lake that the project is in (yes "in") is Lake LBJ, a man-made, controlled lake on the Colorado River — one of the most unique aspects of the pool is that at least two-thirds of the pool is suspended directly above the lake, off the shoreline.

It was 18 months in the making, from the beginning of the project to the start of shotcrete placement. We worked as a team with the engineering firm, the home builder, and of course, our pool builder, Southern Living Pools, and its owner and operator, Brent Dalton.

Since the house was under construction when we did our first site visit (they had to drill the piers in granite and then form-and-pour the slab that the pool would sit on), we knew it wouldn't be a 'next week' kind of situation. This gave us plenty of time to plan and evaluate how we would shoot this project.

We had plenty of time to stockpile sand from the Collier Materials plant in Llano and let it dry, and to fill our silos with cement from Texas Lehigh in Buda. We decided not to move our material and delivery equipment to a closer site in Marble Falls as we had done in the past, but load out of our plant in Liberty Hill instead, roughly 60 mi (97 km) from the project. Since we use dry-mix shotcrete (the old tradename "gunite"), we were able to deliver the dry concrete materials and then mix them on-site. This gave us the maximum time to shoot the material. We also ensured our work stayed within the per-day time frame and noise production parameters stipulated by the HOA.

This project was completed in 2 overall phases. The first phase took 6 days of shooting (including 2 weather

Layout of pool on concrete slab suspended above water

The pool formed with reinforcing bar and plumbing installed

Dry-mix shotcrete placement complete

delays), and we shot 156 yd^3 (119 m^3) of mainly footers. The second phase was over 5 days where we shotcreted the pool and ancillary features. This phase totaled 230 yd^3 (176 m^3) of concrete. This was all shot in August of 2023 in the awesome Texas heat with the added humidity of the adjacent lake. The outside perimeter of this pool includes:

- A lazy river (or channel)
- A spa
- A sitting area with a fire pit
- A tanning ledge/beach area
- Planters
- Bar stools overlooking the infinity edge and the lake
- A catch basin for the overflow of the infinity edge
- Columns

Since minimal forms were used, we saved not only lumber but also significant materials and labor costs. Because minimal forms were erected, we were able to create the curvature as rendered, producing the stunning visual this pool demanded.

We used a 4:1 (sand:cement) concrete mixture design yielding a compressive strength over 4000 psi (28 MPa) with ASTM-C33 and TXDOT-certified sand and a Type I Cement. We had 8 crew members inside the pool and one outside running the Putzmeister AG-15 dry-mix gun. Compressed air was provided by an Ingersoll Rand HP915 and the dry-mix materials delivered from a truck-mounted volumetric mixer by Strong Industries, along with its driver. We were unable to set up next to the pool, so we set the gun in the front of the house, which was under construction at the time, and ran the dry-mix delivery hose through the house with all preventive safety measures in place. We reduced our carbon footprint by using on-site volumetric mixers rather than loading premixed concrete from a ready-mix plant.

The interior of the pool was finished with an exposed pebble aggregate by Centex Plaster, and the pool was completed in October of 2025. This pool was an opportunity to showcase the various ways shotcrete routinely translates a vision into a concrete reality.

2025 OUTSTANDING POOL & RECREATIONAL PROJECT

Project:
Southern Living Pools – Yates Project

Project Location:
Horseshoe Bay, TX

Shotcrete Contractor Company:
Texan Concrete Construction Solutions, LLC dba - Texan Gunite*

Architect Company:
Smith Engineering – Austin, TX

Materials Supplier Company:
Texan Concrete Construction Solutions, LLC dba - Texan Gunite*

Equipment Manufacturer Company:
Putzmeister America*

General Contractor:
Jeff Jackson Homes

Owner:
Southern Living Pools

*ASA Sustaining Corporate or Corporate Member

Juanjose Armenta-Aguirre *is a second-generation 'gunite guy'. He's been in the dry process shotcrete industry since 1999 alongside his father, Juan Armenta. In 2012, he co-founded Texan Gunite and is the COO. Juanjose is an ACI-Certified Shotcreter and has several other certificates through ACI. He's an active member of ACI 304, 524, 506, & 322, serving as the subcommittee chair for materials and durability. He's on the American Shotcrete Association Board of Directors and is an active member of several ASA committees. Juanjose is also the current President for the PHTA Central Texas Chapter, as well as on the Board of Directors for the PHTA Builders Council. He is a PHTA Certified Pool Inspector and a Certified Pool Operator. His undergraduate degree is from the University of Houston, and his graduate studies are from Cardinal Stritch University and St. Francis de Sales Seminary, both in Milwaukee, WI.*

Proyecto Destacado de Piscina y Recreación 2025

Alberca terminada

Southern Living Pools

PROYECTO YATES

Por Juanjose Armenta-Aguirre

Suena el teléfono:

"Junior, ven y tráenos un camión".

Esto no tiene nada de fuera de lo común para mí. Manejo camión cuando se necesita, y esa llamada no fue la excepción, sobre todo con el sitio de obra ubicado en la zona de Marble Falls / Horseshoe Bay, en el centro de Texas. Por la hora del día, yo sería el último camión en llegar y tendría que regresar vacío; de esa forma, la cuadrilla no tendría que esperar material.

Llegué al sitio y bajé del camión, pero antes de que pudiera prepararlo, Trent Dalton (supervisor de campo de Southern Living Pools) se acercó por detrás y puso su mano sobre mi hombro.

"Junior, ¿tienes un minuto? Quiero enseñarte algo".

Lo seguí en una camioneta pickup hasta un punto dentro de la comunidad privada Escondido Lago, en Horseshoe Bay. Al llegar, Dalton me preguntó:

"¿Qué ves?"

Muy confundido, respondí:

"Bueno… veo casas hermosas y el lago".

"¿Qué falta?"

"Déjame adivinar… ¿una alberca?" —respondí en tono de broma.

"¡Exactamente!"

Entonces Dalton me habló de un nuevo proyecto que acababan de adquirir, y comenzamos a planear algo que ninguno de los dos había hecho antes, ni por tamaño ni por ubicación.

Este proyecto residencial de Southern Living Pools se ubica en Apache Tears Road, dentro de la comunidad cerrada de Escondido Lago. El lago donde se encuentra el proyecto (sí, dentro del lago) es el lago LBJ, un lago artificial de nivel controlado sobre el río Colorado. Uno de los aspectos más singulares de la alberca es que al menos dos tercios de ella están suspendidos directamente sobre el lago, más allá de la línea de la orilla.

El proyecto tomó 18 meses desde su inicio hasta el arranque de la colocación del concreto lanzado. Trabajamos como equipo junto con la firma de ingeniería, el constructor de la vivienda y, por supuesto, nuestro constructor de albercas, Southern Living Pools, así como su propietario y operador, Brent Dalton.

Dado que la casa estaba en construcción durante nuestra primera visita al sitio (primero fue necesario perforar pilotes en granito y posteriormente formar y colar la losa sobre la cual descansaría la alberca), sabíamos que no sería un proyecto de “para la próxima semana”. Esto nos dio tiempo suficiente para planear y evaluar cómo íbamos a lanzar el concreto en esta obra.

Tuvimos tiempo de sobra para acopiar arena de la planta de Collier Materials en Llano y dejarla secar, así como para llenar nuestros silos con cemento de Texas Lehigh en Buda. Decidimos no trasladar nuestros materiales y equipos de despacho a un sitio más cercano en Marble Falls, como habíamos hecho en proyectos anteriores, sino cargar desde

Trazo de la alberca sobre la losa de concreto suspendida sobre el agua

Alberca cimbrada con acero de refuerzo e instalaciones hidráulicas

Colocación de concreto lanzado por vía seca terminada nuestra planta en Liberty Hill, aproximadamente a 60 millas (97 km) del proyecto.

Dado que utilizamos concreto lanzado por vía seca (el antiguo nombre comercial “gunita”), pudimos transportar los materiales secos y mezclarlos en sitio, lo que nos dio el máximo tiempo disponible para lanzar el material. Además, nos aseguramos de cumplir con los límites diarios de horario y niveles de ruido estipulados por la asociación de propietarios (HOA).

El proyecto se ejecutó en dos fases generales. La primera fase tomó seis días de lanzamiento (incluyendo dos retrasos por clima) y se colocaron 156 yd^3 (119 m^3) principalmente en zapatas. La segunda fase se llevó a cabo en cinco días, durante los cuales se lanzó el concreto de la alberca y los elementos complementarios, con un total de 230 yd^3 (176 m^3) de concreto.

Todo el trabajo se realizó en agosto de 2023, bajo el intenso calor de Texas y con la humedad adicional del lago adyacente. El perímetro exterior de la alberca incluye:

- Un río lento (o canal)
- Un spa
- Un área de estar con zona para fogata
- Una zona de bronceado / área tipo playa
- Jardineras
- Bancos de bar con vista al borde infinito y al lago
- Un vaso de captación para el desborde del borde infinito
- Columnas

Gracias al uso mínimo de cimbra, no solo ahorramos madera, sino también cantidades significativas de materiales y costos de mano de obra. Al emplear cimbras mínimas, pudimos crear las curvaturas tal como fueron renderizadas, logrando el impacto visual que esta alberca exigía.

Utilizamos un diseño de mezcla 4:1 (arena:cemento), logrando una resistencia a la compresión superior a 4,000 psi (28 MPa), con arena certificada ASTM C33 y TXDOT, y cemento Tipo I. Contamos con ocho integrantes de la cuadrilla dentro de la alberca y uno en el exterior operando una máquina de vía seca Putzmeister AG-15. El aire comprimido fue suministrado por un compresor Ingersoll Rand HP915, y los materiales secos se entregaron mediante un mezclador volumétrico montado en camión de Strong Industries, junto con su operador.

No fue posible instalar el equipo junto a la alberca, por lo que se ubicó la máquina al frente de la vivienda, que aún estaba en construcción, y se tendieron las mangueras de suministro a través de la casa, implementando todas las medidas preventivas de seguridad. Reducimos nuestra huella de carbono al utilizar mezcladores volumétricos en sitio, en lugar de transportar concreto premezclado desde una planta de concreto.

El interior de la alberca se terminó con un acabado de agregado expuesto tipo pebble, aplicado por Centex Plaster, y la alberca fue concluida en octubre de 2025. Este proyecto representó una oportunidad para demostrar las múltiples maneras en que el concreto lanzado transforma de forma rutinaria una visión en una realidad de concreto.

PROYECTO DESTACADO DE ALBERCAS Y RECREACIÓN 2025

Proyecto:
Southern Living Pools – Proyecto Yates

Ubicación del Proyecto:
Horseshoe Bay, TX

Contratista de Concreto Lanzado:
Texan Concrete Construction Solutions, LLC dba – Texan Gunite*

Arquitecto / Ingeniero:
Smith Engineering – Austin, TX

Fabricante de Equipo:
Putzmeister America*

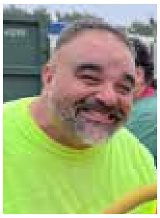
Proveedor de Materiales:
Texan Concrete Construction Solutions, LLC dba – Texan Gunite*

Contratista General:
Jeff Jackson Custom Homes

Propietario del Proyecto:
Jeff Jackson Custom Homes

Otra Empresa del Proyecto:
Southern Living Pools

**Miembro corporativo de la American Shotcrete Association (ASA)*



Juanjose Armenta-Aguirre *es un “gunitero” de segunda generación. Ha trabajado en la industria del concreto lanzado por vía seca desde 1999 junto a su padre, Juan Armenta. En 2012 cofundó Texan Gunite, donde actualmente se desempeña como COO. Juanjose es lanzador de concreto certificado por ACI y cuenta con varias certificaciones adicionales a través del ACI.*
Es miembro activo de los comités ACI 304, 524, 506 y 322, y funge como presidente del subcomité de materiales y durabilidad. Forma parte del Consejo Directivo de la American Shotcrete Association (ASA) y participa activamente en varios de sus comités. Actualmente es Presidente del Capítulo Central de Texas de la PHTA y miembro del Consejo Directivo del PHTA Builders Council. Es Inspector de Albercas Certificado por PHTA y Operador de Albercas Certificado. Obtuvo su licenciatura en la Universidad de Houston y realizó estudios de posgrado en Cardinal Stritch University y St. Francis de Sales Seminary, ambos en Milwaukee, Wisconsin.

2025 Honorable Mention Project

Pompeys Pillar National Monument Stabilization

By Lucille Mooney and Larry Mooney

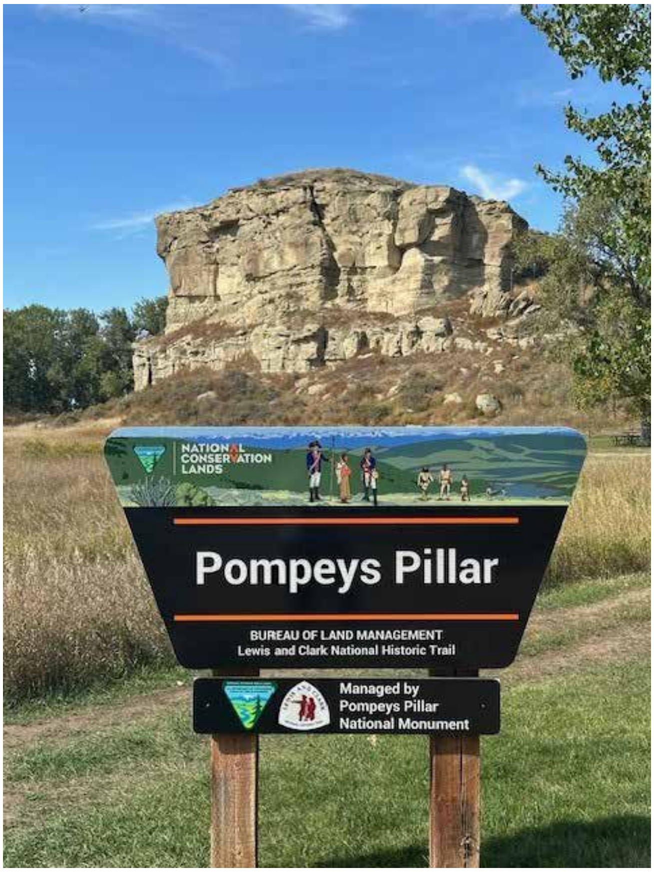
Pompeys Pillar is one of the most significant sandstone landmarks in the United States, made famous by William Clark of the Lewis and Clark Expedition, who carved his signature into the stone in 1806. This fragile historic inscription, along with the surrounding sandstone formation, was in danger of being lost to erosion and instability.

CHALLENGES

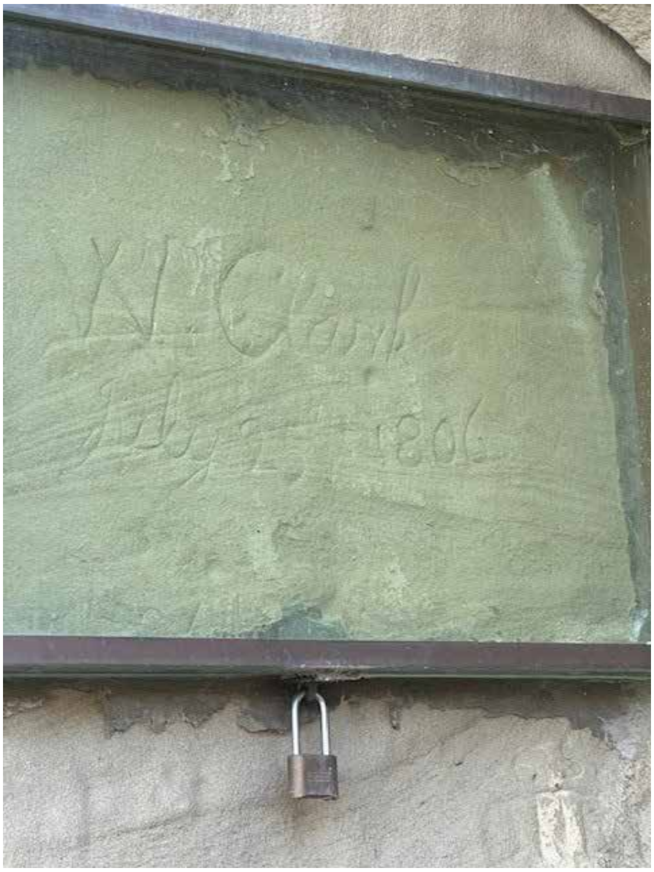
The site was half a mile (0.8 km) from the main access road. We had to ferry the supersacks through a hay field on a muddy two track path when it rained — a slushy and muddy path when it would snow — because we had to limit the size of the project footprint.

Between limitations and weather patterns, planning was a challenge as well. The Bureau of Reclamation project engineer had to be on-site before we could start in the morning, but he lived 125 mi (200 km) from the job site and had to drop his young child at daycare at 8 a.m. So, the team had at least a two-hour wait each morning before starting (and that was if the roads were in good condition). The availability of the project engineer also limited the amount of work the drilling/general contractor could perform before we started to shotcrete.

On top of that, it seems that the wind blows all the time in Montana. This would regularly prevent work because the drillers were suspended from a crane by cables, so they could not drill in high winds. With the cold, we also had to haul in warm water — 300 gal (1150 l) at a time — 25 mi (40 km) from Billings to the job site on the days we were shooting.



Entrance to Pompeys Pillar National Monument



Clarks' framed and protected signature

Pompeys Pillar completed rock stabilization

TripTych drilling crew placing rock anchors

Partial installation of the second layer of reinforcing, ready for structural shotcrete placement

We did install 3000 ft^2 (280 m^2) of 4x4 W4xW4 welded wire mesh and 500 pieces of #5 (#16M) reinforcing bar, all bent to conform to the substrate laid out at 6 in. (150 mm) each way in two layers, shooting in the first layer, then following with the second layer. We shot 20 yd^3 (15 m^3) of Quikrete Shotcrete MS in each layer, then another 20 yd^3 of colored Quikrete for the final architectural layer applied by Shotcrete Montana and carved by the skilled craftsmen at Ocean Rock Art Inc.

COLLABORATION

In collaboration with TripTych Construction and Ocean Rock Art Inc, a comprehensive shotcrete stabilization and hyper-realistic sculptural restoration was performed to preserve the monument for future generations. The project combined rock stabilization, structural shotcrete engineering, artistic rock sculpting, and logistical innovation in an extremely sensitive and challenging environment.

- Triptych Construction performed specialized drilling using a crane-suspended drill rig to anchor into the sandstone.
- Shotcrete Montana LLC installed the #4 and #5 (#13M and #16M) reinforcing bars, bent and contoured to conform to the natural shape of the sandstone formation.

A completed section of welded wire mesh and bent reinforcing bars waiting for the first structural shotcrete placement

First layer of structural shotcrete in place

Covered scaffolding providing ready access and protection from the weather

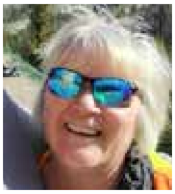
- The structural system used two layers of reinforcing bars, tied into the native formation and designed to support the shotcrete placement while respecting the fragile historic surface.
- Dry-mix shotcrete placement provided both structural stabilization and a concrete base layer fit for sculpting.
- Skilled rock artisans from Ocean Rock Art Inc created a hyper-realistic sandstone finish, replicating the texture, layering, and coloration of the native formation.

CONCLUSION

The stabilization of Pompey's Pillar is a landmark example of how shotcrete placement can preserve history while meeting the need for structural integrity and modern code requirements. This project not only protected a critical piece of American heritage but also showcased the adaptability of shotcrete placement in areas with challenging access, sensitive environmental and historic preservation conditions.

Through engineering excellence, quality shotcrete placement, and artistic craftsmanship, the project team ensured that Clark's signature — and the story of the Lewis and Clark Expedition — remain preserved for generations to come.

Larry Mooney *is the Vice President of Shotcrete Montana LLC. He is an ACI certified shotcreter and both an ASA and ACI member, with over 30 years of mining experience in Canada and the USA. Larry specializes in the dry mix process and works as a shotcrete consultant and certified shotcreter.*



Lucille Mooney *is the President/CEO of Shotcrete Montana LLC, and has been the owner since 2006. Shotcrete Montana LLC is a member of the ASA and ACI.*

2025 HONORABLE MENTION PROJECT

Project:
Pompeys Pillar National Monument Stabilize

Project Location:
Pompeys Pillar, MT

Shotcrete Contractor Company:
Shotcrete Montana LLC*

Engineer Company:
Bureau of Land Management- MT State OFC

Materials Supplier Company:
The Quikrete Companies*

Equipment Manufacturer Company:
REED Shotcrete Equipment*

General Contractor:
TripTych Construction LLC

Additional Team Members:
Ocean Rock Art US*

Owner:
Bureau of Land Management - MT State OFC

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• What due dates to keep in mind
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2025 Honorable Mention Project

Historic district regulations required that no visible changes be made to the front of the home (LEFT) during renovation and pool construction, but we made it a party in the back (RIGHT).

Business in the Front, Party in the Back

By Ryan Oakes

PROJECT OVERVIEW

This project began as a conventional form-and-pour pool installation before the homeowner recognized that the scope, access limitations, and structural implications required a specialized pool contractor and design professional. By the time Revolution Gunite was engaged, excavation was largely complete and footings were already in place — revealing a set of constraints that ultimately made shotcrete not just advantageous, but essential.

The pool is located in a dense historic neighborhood with limited access, strict permitting requirements, and adjacent structures on all sides. The final design integrates the pool shell as both a recreational element

Nearly finished interior photo

and a structural component of the residence. Approximately half of the pool is located indoors, with the remainder extending into a modern rear addition of the home. At several locations, the pool shell abuts the existing foundation walls.

Excavation extended directly to the property line (LEFT), leaving no room for ground-supported forming and creating significant safety and stability concerns. Conditions during excavation illustrate the limited tolerance for delay. Construction sequencing progressed rapidly to mitigate further soil movement and structural risk (RIGHT).

SITE CONSTRAINTS AND STRUCTURAL CHALLENGES

The most significant challenge involved soil stability and proximity to neighboring structures. Excavation extended directly to the adjacent property line, exposing unstable soils and creating a risk to the neighboring home. Compounding the issue, portions of the homeowner's foundation were exposed and required immediate support. Helical piers were installed to temporarily support the existing structure while excavation and pool construction proceeded.

In its final configuration, the pool shell functions as a retaining wall for the adjacent property and as a load-bearing structural wall for a portion of the residence. A deep, concealed well for an automatic floating pool cover was constructed immediately adjacent to the home's foundation, leaving virtually no room for conventional forming or backside access.

SHOTCRETE MEANS AND METHODS

Given the access limitations and structural demands, shotcrete was the only viable method of concrete placement. Floor placement was sequenced first, with reinforcing steel for the walls stubbed upward. In several areas, wall-to-floor intersections exceeded 3 ft (0.9 m) in depth with heavily congested reinforcing steel.

The high velocity inherent to shotcrete placement allowed material to be placed efficiently at the back of deep sections with excellent consolidation, even in areas where vibration or conventional placement methods would have been impractical or impossible.

Walls were shot with the permanent backfill and drainage system already in place. A combination of geogrid and gravel was used to create a stabilized backfill zone between the pool shell and the adjacent property. This system served multiple purposes: It eliminated the need for temporary soil anchors that would have crossed under the neighboring home, provided long-term drainage, and functioned as permanent formwork where conventional forming could not be installed due to lot constraints.

REDUCED FORMING AND ACCELERATED SCHEDULE

Forming was minimized throughout the project — not only in areas where access made it impractical, but also where the pool shell was placed directly against foundation walls and footings. In many locations, forming

Rear of the residence showing existing footings from the original planned form-and-pour construction (LEFT). All previously installed footings were removed prior to shotcrete work. Reinforcing steel installation showing stubbed vertical bars for tying the floor to the pool walls (RIGHT).

Shotcreter placing material beneath cantilevered foam forms for the engineered footing extension. Perimeter footings were shot first, followed by floor infill to create a continuous floor placement. High-velocity shotcrete placement ensured proper consolidation in these confined areas.

Completed pool floor with formed notch for subsequent wall placement.

Notched floor with reinforcing steel in place at a cut-in step location prior to wall placement.

installation and subsequent removal were eliminated entirely.

By using shotcrete placement, more than a month of construction time was removed from the schedule. The ability to place concrete without extensive formwork also reduced safety risks and simplified sequencing on an already constrained site.

SPECIALTY DETAILS AND CRAFTSMANSHIP

The automatic floating cover system introduced additional complexity. The cover well required precise geometry and intricate detailing, including continuous shelves running the full length of the 82 ft (25 m) lap pool on both sides. These shelves were hand-carved directly into the shotcrete shell to provide support for the insulating cover — details that would have been extremely difficult to achieve with conventional formwork.

Entry steps were formed by cutting voids directly into the shotcrete walls after placement but before final set. The stiff, cohesive concrete mixture design allowed steps to be sculpted cleanly during the transition between the plastic and hardened states of the concrete, producing crisp geometry without the need for secondary pours or inserts.

HISTORIC CONTEXT AND FINAL OUTCOME

Constructed within a designated historic district, the project required strict adherence to permitted working hours and careful coordination on a narrow residential street. The flexibility of volumetric delivery and dry-mix shotcrete placement proved critical in meeting these constraints while maintaining production efficiency.

The completed pool reflects a striking contrast between the historic front of the home and the modern rear addition — hence the project's name, *Business in the Front, Party in the Back*. Beyond its architectural impact, the pool serves as a structural extension of the residence and a permanent solution to complex site constraints.

This project demonstrates

how shotcrete, when applied with thoughtful engineering and skilled craftsmanship, can solve problems that conventional construction methods simply cannot — delivering structural performance, architectural flexibility, and schedule efficiency in a single operation.

Wall forms prepared and ready for shotcrete placement.

Shotcreter placing concrete while a blowpipe operator maintains a rebound-free section, ensuring proper encapsulation of reinforcing steel.

Construction joint prepared between wall lifts, clean and intentionally roughened to provide full bond for the subsequent shotcrete placement.

Ryan Oakes *is President of Clearwater Construction Group, Inc., Revolution Gunite, and Revolution Pool Finishes, all of which are award-winning firms in their respective trade. He continually aims to raise the bar in the concrete swimming pool construction industry. Oakes is a member of ACI Committee 506-Shotcreting, and ACI Subcommittee 506-H-Shotcreting Pools. He also serves as Secretary to ACI Committee 322-Concrete Pool & Watershape Code. He serves as Chair of the ASA Pool & Recreational Shotcrete Committee, a voting member of the ASA Contractor Qualification Committee and former Board of Directors for ASA.*

2025 HONORABLE MENTION PROJECT

Project:
Business in the Front, Party in the Back

Project Location:
Raleigh, NC

Shotcrete Contractor Company:
Revolution Gunite*

Engineer Company:
Waterforge, Inc

Materials Supplier Company:
Revolution Gunite*

Swimming Pool Contractor:
Raleigh Pools

Owner:
Jiten Patel

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2025 Honorable Mention Project

Figs. 1 and 2: Architectural renderings of The United Bldg.

North America's Tallest Façade Retention System

By Mark Reinders, P.Eng.

In the heart of downtown Toronto, ON, Canada, a full city block at 481 University Avenue and 210 Dundas Street West has become the site of one of the most complex heritage preservation efforts ever attempted in North America. The development of the United Bldg. (Figs. 1 and 2), a 50-story mixed-use tower, required the complete in-place retention of the façades of two historically significant heritage sites (Fig. 3):

- A 1928, nine-story Beaux-Arts structure, originally owned by the Maclean Publishing Company, located at 210 Dundas St.
- A 1961, ten-story Modern Classical building, serving as an expansion for the Maclean Publishing Company, located at 481 University Ave.

Due to this designation, all original finishes — brick, stone, concrete, and steel — had to remain undisturbed and fully supported throughout construction. At ten stories tall, the façade retention system (FRS) designed for this project became a monumental engineering and construction marvel, unprecedented in the industry. The complexity of this project was only amplified by the spatial limitations imposed. Dense urban infrastructure — including streetcars, subway tunnels, and congested utilities — restricted the available options for the FRS design and imposed stringent monitoring criteria. The solution needed to restrict ground settlement to less than 3 mm (0.1 in.) and façade movement of 15 mm (0.6 in.). This led to the development of a highly integrated hybrid support system, merging elements of

Fig. 3: 481 University Avenue and 210 Dundas Street West historical façades

Fig. 4: Floor-by-floor demolition operations

the existing structure with the FRS and the support of excavation (SOE) design to allow four levels of underground construction beneath the retained façades and structure.

Green Infrastructure Partners (GIP) is a leading Canadian specialty contractor with over 50 years of experience in deep foundations and shoring works. They were selected as the specialty service subcontractor responsible for delivering the demolition, support of excavation, façade retention system, and ultimately, the integration of all these systems. This included a controlled demolition of the heritage structures, installing deep foundation elements around and within the structures, façade support with structural steel, transferring the façade's weight onto the new deep foundation elements, and finally providing earth retention with lateral supports and shotcrete.

DEMOLITION IN TIGHT QUARTERS

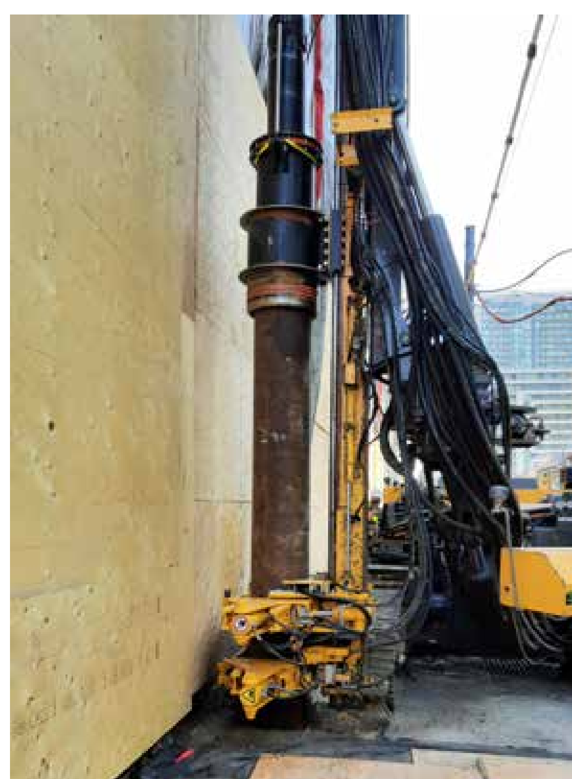
The initial phase of construction required the controlled demolition of the original interiors of 210 Dundas Street West and 481 University Avenue, all while the façades remained in place (Fig. 4). GIP crews used compact machines, hoisted floor-by-floor to surgically dismantle the slabs, beams, and columns, dropping debris to the lower floors.

To ensure stability of the façade, the first bay of columns, slab, and grade beams were left in place and supported with additional structural steel. Combining the existing structure and new reinforcement provide an economical and efficient means of supporting the historic façades throughout the construction phases.

DEEP FOUNDATION ELEMENTS

The largest challenge on this project was re-supporting the FRS — inclusive of the façade, existing structure, and new reinforcement — onto temporary foundations. This would allow the removal of the existing footings and basement walls as well as the installation of new permanent foundations for the future 50-story structure. To facilitate this massive load transfer, two different forms of SOE were installed on the perimeter, to support half the loads transferred to the exterior. Discrete king piles were installed within the building's footprint to support the interior half of the loads.

The primary SOE consisted of a secant pile wall along



Figs. 5 and 6: Cased Kelly drilling of secant piles (LEFT) & drilling of micropiles (RIGHT)

Figs. 7 and 8: King pile drilling and placement near FRS (LEFT), placement of king pile in drilled shaft (RIGHT)

two-thirds of the perimeter, where minimal site restrictions existed. Cased Kelly techniques were used to drill 1.0-m (3.3-ft) diameter shafts in an overlapping manner to create a continuous concrete wall below grade (Fig. 5). The majority of these drilled shafts contained 6 MPa (870 psi) concrete as well as W610x217 wide flange beams. In areas directly supporting the high vertical loads from the FRS, the properties were upsized. The drilled shaft diameter increased to 1.3 m (4.3 ft), the concrete strength increased to as high as 55 MPa (8000 psi), and the steel reinforcement increased to W760x257. This drilling occurred 400 mm (16 in.) off the face of the façade. Minimal vibrational transfer or movement of the FRS were identified during this work.

The secondary SOE required the use of micropiles and shotcrete on the remaining third of the site perimeter. This area had considerable limitations imposed, restricting surcharge loading over a below-grade subway station and spatial restrictions due to at-grade streetcars. As such, hollow structural section (HSS) 406 x 14.6 mm (16 x 0.6 in.) diameter micropiles were installed as close as 200 mm (8 in.) to the façade (Fig. 6). These elements allowed flexibility in location and position, ensuring they were spaced at no more than 1.2 m (4 ft) apart. In areas of high FRS loading, they were clustered in groups of 4, 6, or 8, with 100 mm (4 in.) between them. To provide support during excavation, shotcrete and mesh were applied (detailed later in this article). The micropiles were filled with a limestone-based grout, using a water-reducer and viscosity-modifier admixtures to both facilitate placement and to consistently achieve 60 MPa (8700 psi) strengths.

Almost a year after SOE drilling was completed, the interior space was sufficiently demolished to allow for the installation of king piles. Cased Kelly techniques were used again to drill 1.0-m diameter foundation elements that supported the FRS within the new building's footprint (Fig. 7). These king piles consisted of W360x634 beams with a 60 MPa self-consolidating concrete toe to support design loads over 6000 kN (675 tons). The toe of the king piles received 108 Nelson studs and an uplift plate to fully engage the concrete toe (Fig. 8). Only 16 were installed, as close as 75 mm (3 in.) to the edge of the FRS. Position and verticality tolerances were stringent, as many of the king piles were cast into future permanent columns.

Tying the FRS and SOE Together

At grade, multiple retention trusses were built around the existing columns at the main floor elevation. It extended through engineered pockets in the façade to bear on the cap beam that spanned the SOE. The interior side ended at the edge of the in-place slab to facilitate placement of the basement level truss. This basement truss was referred to as the 'transfer truss', and it sat on top of all of the king piles, connecting the 16 of them together. Once the transfer truss was in place, the retention trusses were spliced beyond the in-place slab, to bear directly on top of the transfer truss. Finally, jacking pedestals were installed around all 50 existing columns. Each pedestal had an upper bearing surface secured to the column, while the lower bearing surface was secured to a retention truss. Figs. 9 and 10 provide illustrations of how these elements came together to facilitate the load transfer.

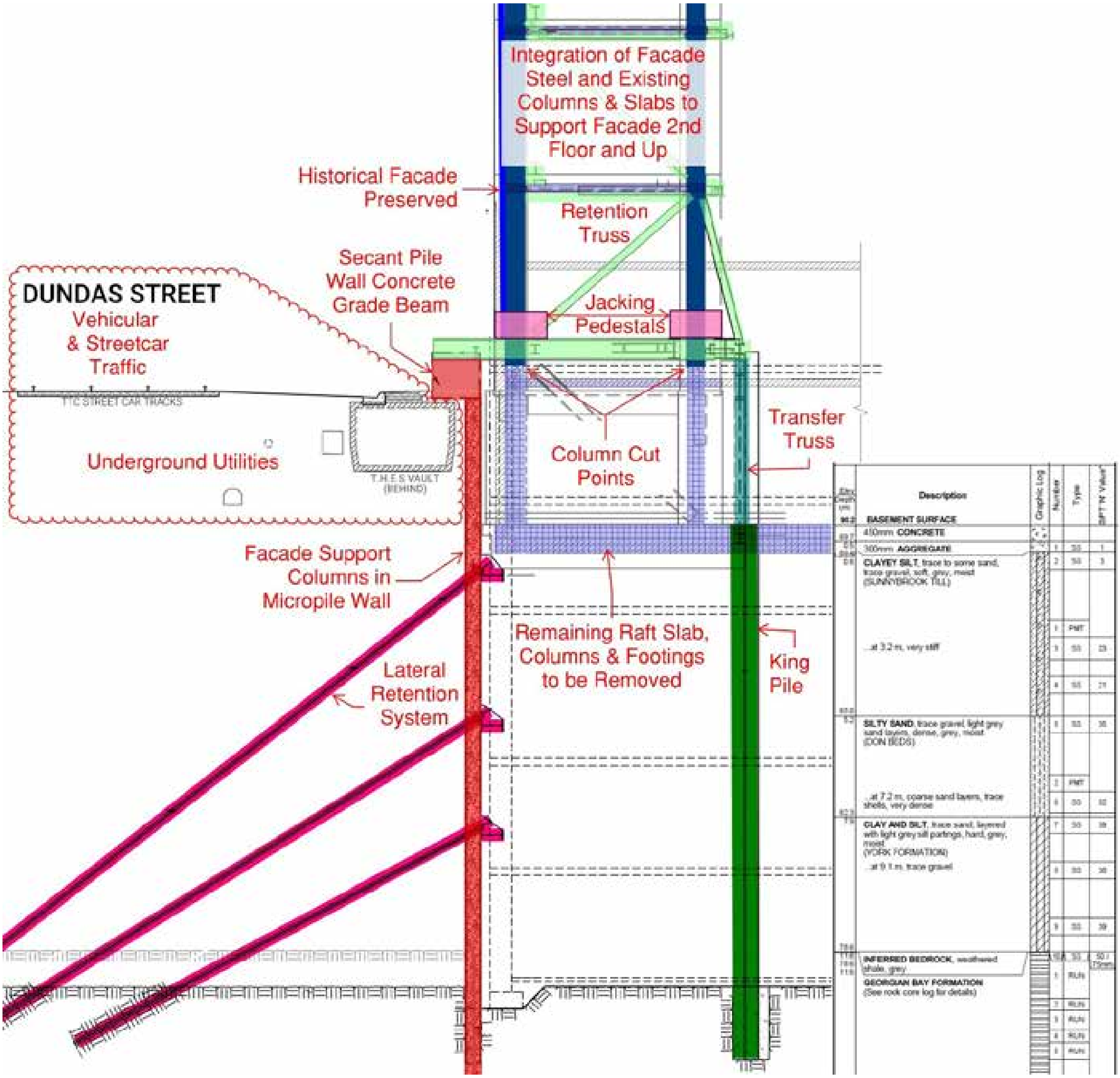


Fig. 9: FRS-SOE Section View

TRANSFERRING THE LOAD

Following the completion of the hybrid SOE-FRS system, the next major milestone was to safely transfer the full weight of the heritage façades from their original footings onto the newly constructed support system (Fig. 11). The weight of the entire system was estimated around 20,000 metric tons (22,000 tons), with a +/- 15% variation. To mitigate excessive movement and manage the load variability, the FRS was divided into 8 segments (1, 2, 3…, 7, 8), and the load transfer process was divided into 5 steps (A, B, C, D, E). This resulted in 40 stages of work to fully transition the load, sequenced as 1A, 2A, 3A…, 6E, 7E, 8E, taking over six weeks to complete. The 5 steps were:

A. Jack to 50% of expected load. Investigate anomalies. Temporarily Shim. Monitor strain.

B. Jack to 75% of expected load. Investigate anomalies. Temporarily Shim. Monitor strain.

C. Sever existing columns below jacks and re-connect to allow compression-only load through column (no tension or movement). Monitor strain. Monitor displacement across compression-only connection.

D. Jack to either 100% of expected load, 100% of expected strain, or displacement across compression-only connection. Temporarily shim. Monitor strain. Monitor displacement.

E. Secure all jacking points with permanent shims to lock in load on retention trusses.

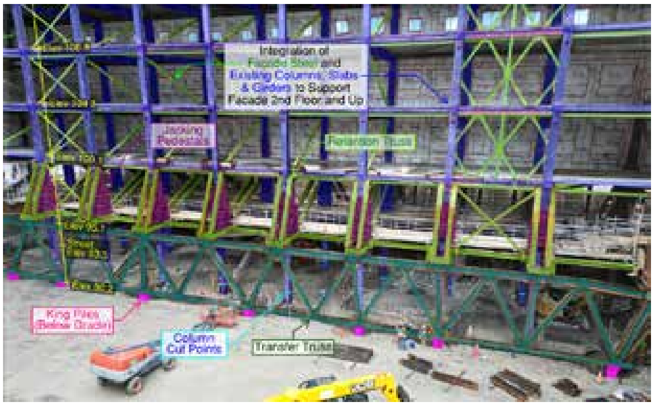


Fig. 10: FRS-SOE Elevation View


Fig. 11: Jacks around existing columns


Fig. 12: Basement wall demolition, exposing micropile wall


Fig. 13: Micropile-shotcrete and secant pile SOE

LATERAL SUPPORT & SHOTCRETE PLACEMENT

With the façade fully supported, the excavation commenced. The existing footings were demolished as the excavation progressed, however more care needed to be taken with the existing basement walls. When removing these walls, the deep foundation elements were exposed. As mentioned earlier, two-thirds of the site perimeter was a secant pile wall, resulting in a continuous concrete wall that retained the earth and infrastructure behind it. The other third exposed the steel casing of the micropiles, either in clusters or spaced at 1.2 m (Fig. 12). The earth remained exposed, therefore excavation lifts were limited to a height of 1.5 m (5 ft) until shotcrete could be applied.

The wet-mix shotcrete mixture was supplied by Canada Building Materials (CBM) as a 35 MPa (5000 psi), air-entrained mix with a 10 mm (0.4 in.) aggregate and a slump of 60 +/- 20 mm (2.5 +/- 0.75 in.). 75 mm hardline were secured to the secant pile walls at either end of the micropile zone to allow flexibility when placing. Flex line then extended to two points on the site perimeter where a shotcrete pump would be positioned, depending on where the shoot was occurring.

Each 1.5-m lift was prepared by securing studs to the face of the micropile as well as rods in the middle of the 1.2-m bays. These were used to support 2 layers of wire mesh, both being 102x102 MW11.1/11.1 with 75 mm in between. Once the wall was prepared, the concrete was delivered and pumped to the shotcreters at the base of excavation, where it was shotcreted by hand nozzling, without the use of mechanized equipment. The total shotcrete thickness was 150 to 200 mm (6 to 8 in.) deep, ensuring a minimum of 50 mm (2 in.) coverage on the outermost layer of mesh. The surface was left as gun finish, as the permanent wall for the future structure was to be built in front (Fig. 13).

Part of the SOE design required various lateral supports in both the secant pile wall and the micropile-shotcrete wall. They consisted of:

- **Tiebacks:** Anchors drilled and grouted into rock behind the wall, then tensioned to impart lateral load into the SOE
- **Walers:** Horizontal steel beams welded to the face of the vertical support that help distribute tieback loads across multiple vertically drilled elements

At the micropile-shotcrete wall, additional internal walers were required to support the lateral loads at the tieback location (Fig. 14). This required hand excavating and an additional 150 mm between the micropiles and installing a steel beam, field coped and welded tightly against the sides of the micropiles. This process was extremely time consuming, and it became quickly evident that this operation drove the critical path of the job and would delay the schedule.

GIP worked closely with the SOE designer, Grounded Engineering, to replace this internal waler with a shotcrete panel (Fig. 15). The shotcrete was achieving design strength after 24 hours, meaning it could adequately support the tieback loads the day after shooting. A solution was developed to install a 1 m tall rebar panel, consisting of #10M (#3) rebar at a spacing of 125 mm x 125 mm (5 x 5 in.), welded to the edge of the micropiles. This was installed in addition to the two layers of mesh. The depth of the shotcrete was increased to 250 mm (10 in.) at these locations, and great care was taken to ensure it encapsulated the 3 layers of reinforcement and stacked well. This adjustment greatly improved productivity and put the schedule back on track.

PROJECT COMPLETION INSIGHTS

The complexity and constraints of the United Bldg. project demanded early and continuous coordination between all stakeholders. Regular communication and coordination

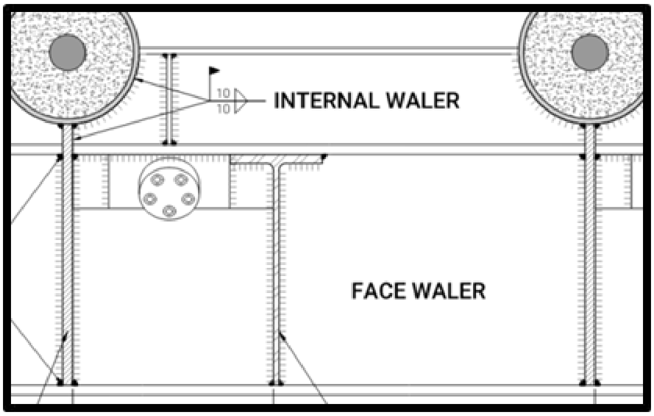


Fig. 14: Micropile Internal Waler Detail

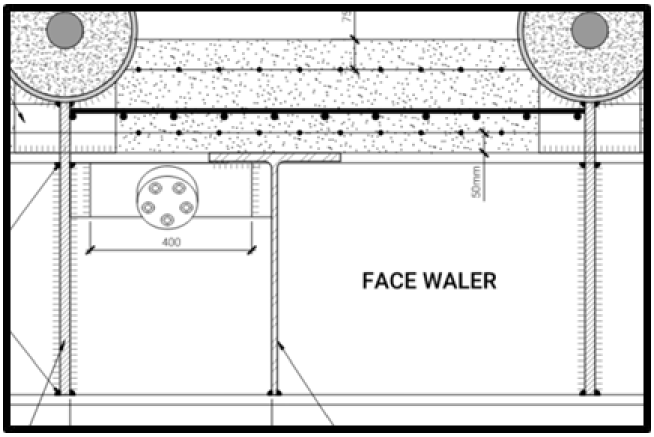


Fig. 15: Revised Micropile Internal Shotcrete Panel

Figure 16: North America's Tallest Façade Retention System

between the owner, architects, designers, consultants, constructors, inspectors and vendors ensured that shifting site conditions were accounted for in real time. This team-first approach was maintained from early in the design process through to the completion of the four-story below-grade excavation. Insights from each party were respected and integrated to improve quality, safety, and efficiency across all phases. The result was the successful delivery of one of Toronto's most complex foundation systems, and the construction of North America's tallest façade retention system (Fig. 16).

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the valuable insights and support provided by the project team, including Davpart Inc. (Project Owner), B+H Architects (Architects) EllisDon (General Contractor), Read Jones Christoffersen Ltd. (Structural and Façade Engineer), Grounded Engineering (Excavation Support & Monitoring Engineer) and Canada Building Materials (Shotcrete Supplier). Their expertise and collaboration were instrumental in the development of this article.

***Mark Reinders**, P.Eng., is a senior project manager at Green Infrastructure Partners based in Markham, ON, Canada. With over 15 years of experience in the deep foundation industry with widely varying expertise, he prides himself at finding efficient and constructable solutions to a client's subsurface challenges, as well as growing young professionals in the industry.*

2025 HONORABLE MENTION PROJECT

Project:
North America's Tallest Retained Façade

Project Location:
Toronto, ON, Canada

Shotcrete Contractor Company:
Green Infrastructure Partners Inc.*

Engineer Company:
Grounded Engineering

Materials Supplier Company:
Canadian Building Materials

General Contractor:
EllisDon Residential

Owner:
481 Uni Investments Inc

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SHOTCRETE CALENDAR

Please check with the meeting provider as some meetings may be postponed or cancelled after publication of this issue of Shotcrete.

MARCH 15-18, 2026	**2026 ICRI Spring Convention** JW Marriott Nashville | Nashville, TN
MARCH 27-29, 2026	**ACI Shotcreter Certification (Wet-Mix) | Skatepark Summit** Kaaterskill Kahncrete | Saugerties, NY
MARCH 29-APRIL 1, 2026	**ACI 2026 Spring Concrete Convention** Hyatt Regency O'Hare | Rosemont/Chicago, IL
APRIL 15-17, 2026	**ACI Shotcreter Certification (Wet- & Dry-Mix)** Minova | Millstadt, IL
APRIL 24-26, 2026	**ACI Shotcreter Certification (Wet- & Dry-Mix)** Applied Shotcrete | Sebastopol, CA
MAY 31-JUNE 3, 2026	**ASTM Committee Meetings | C09 Concrete & Concrete Aggregates** Hyatt Regency Dallas | 300 Reunion Blvd. E | Dallas, TX
OCTOBER 7-9, 2026	**ACI Shotcreter Certification (Wet- & Dry-Mix)** Minova | Millstadt, IL
OCTOBER 23-25, 2026	**ACI Shotcreter Certification (Wet- & Dry-Mix)** Applied Shotcrete | Sebastopol, CA
NOVEMBER 17-19, 2026	**International Pool | Spa | Patio Expo 2026)** Ernest N. Morial Convention Center | New Orleans, LA
DECEMBER 6-9, 2026	**ASTM Committee Meetings - C09 Concrete & Concrete Aggregates** Hyatt Regency Jacksonville Riverfront | 225 East Coastline Drive | Jacksonville, FL
MORE INFORMATION	To see a full list, current updates, and active links to each event, visit www.shotcrete.org/calendar.

2026 Open Shotcreter Certification Sessions

March 27-29, 2026: ACI Shotcreter Certification (Wet-Mix) | Skatepark Summit | Kaaterskill Kahncrete | Saugerties, NY
April 15-17, 2026: ACI Shotcreter Certification (Wet- & Dry-Mix) | Minova | Millstadt, IL
April 24-26, 2026: ACI Shotcreter Certification (Wet- & Dry-Mix) | Applied Shotcrete | Sebastopol, CA
May 15-17, 2026: ACI Shotcreter Certification (Wet- & Dry-Mix) | Spanish | Texan Gunite | Cedar Park, TX
October 7-9, 2026: ACI Shotcreter Certification (Wet- & Dry-Mix) | Minova | Millstadt, IL
October 23-25, 2026: ACI Shotcreter Certification (Wet- & Dry-Mix) | Applied Shotcrete | Sebastopol, CA

***Elsa Defforey** is currently completing a Master's degree at Université Laval, as part of a double degree program with Arts et Métiers, France, School of General Engineering. Her research project aims to adapt accelerator conditions to spray concrete of low-carbon binders, particularly Type 1L (GUL) cement. She chose to specialize in civil engineering after gaining valuable hands-on experience during an internship on a construction project, and she is now committed to integrating an approach that is both ecologically thoughtful and practically feasible into her graduate research project.*

DEFFOREY'S RESEARCH PROJECT

THE *LABSPRAYER*: A TOOL TO EXPLORE WET-MIX SPRAYING OF LOW-CARBON BINDERS

Reducing the carbon footprint of cementitious materials is a major ongoing challenge in the entire construction industry, and the shotcrete world is no exception. As clinker production is responsible for the largest share of concrete's carbon emissions, the use of low-carbon binder solutions, particularly those with reduced clinker content in favor of mineral additions, appears to be a promising solution for improving the environmental performance of buildings. However, their usage in demanding applications — such as shotcrete placement — raises additional challenges, including their fresh-state behavior, hydration kinetics, and compatibility with existing chemical admixtures.

This lack of field performance knowledge hinders the acceptance and use of these binders on construction sites, thereby limiting their potential for carbon emission reduction. Consequently, a more detailed understanding of the mechanisms involved in shotcrete placement using low-carbon binders is required by our industry. Academic research can provide answers based on rigorous experiments conducted in a controlled environment, with the objective of ensuring the highest possible level of reproducibility.

To achieve this goal, the Université Laval Shotcrete Laboratory has acquired an innovative device: A small-scale wet-mix concrete spraying pump. This *LabSprayer*, developed and provided by Normet, differs from traditional spraying equipment in its ability to spray small quantities of mortar while allowing precise control of the dosage of rapid-set accelerating admixtures injected at the nozzle. It provides the flexibility of small batches (3.2 gal / 12 l), while combining all the elements of high velocity placement. This tool allows observation of mortar behavior under pressure, as well as its stability and texture during spraying. The experiments are reproducible, fast, and require only limited amounts of material. Consequently, the *LabSprayer* provides a suitable framework for analyzing, comparing, and optimizing low-carbon binders.

Moreover, both American and Canadian standards governing portland limestone cement remain relatively permissive and allow a wide range of limestone contents, qualities, origins, and particle size distributions. This variability can lead to significant differences in the fresh-state behavior of concrete before, during, and after placement. A focus will be placed on rheology, with the aim of assessing the influence of particle size distribution and the cement grinding process on granular arrangement mechanisms. The objective is to study mortar using the *LabSprayer* and to gain insight into the expected behavior of concrete when processed with an industrial wet-mix pump.

The research project is conducted in collaboration with industrial partners who provide a variety of cements and admixtures currently available on the market, thereby ensuring that the materials studied are representative of those used in construction.

The project is in its exploratory phase, during which various binders and set accelerators are tested to help define the system's limits and capacity. For the various samples prepared, calorimetric testing is conducted to track hydration kinetics and evaluate the effects of admixtures on early-age reactions for a given binder type. Mechanical strength development is also monitored through early-age compressive strength tests. The combination of these results enables highlighting the relationship between hydration heat and strength development and defining a range of formulations compatible with the expected performance requirements of a project.

The main objective of this study is to define accelerator

LabSprayer: *Two funnels are visible. The grey funnel connects to the larger cylinder for mortar, and the black funnel connects to the smaller cylinder for admixtures. The mixing between the mortar and the air–accelerator blend takes place in the nozzle at the end of the hose, visible in the picture.*

dosage strategies that balance operational performance with the reduction of environmental footprint in wet-mix shotcrete. Specifically, the aim is to precisely determine the minimum quantity of accelerator required to achieve setting times compatible with shotcrete application, while ensuring the development of mechanical strength that satisfies performance requirements. In parallel, the carbon footprint is evaluated globally, accounting for both cement and admixtures. This approach seeks to provide the scientific basis necessary for the reliable implementation of portland limestone cement in shotcrete, an essential condition for its adoption and the realization of the potential reduction in the environmental footprint.

MARK JOLIN'S (DEFFOREY'S PROFESSOR) RECOMMENDATION FOR THE SCHOLARSHIP

Elsa is an exceptionally bright and capable graduate student, driven by curiosity and a talent for experimentation. The project she has undertaken in the Shotcrete Laboratory at Université Laval is the first of its kind. She is using a small-scale wet-mix shotcrete pump to evaluate how well modern cements and binders perform in wet-mix shotcrete applications. Her work focuses particularly on binders containing supplementary cementing materials and various fillers, tested both with and without set-accelerating admixtures, to assess their pumpability and early-age strength behaviour. Ultimately, her goal is to propose practical guidelines for engineers and practitioners who face challenges in the field.

MAPEI UNDERGROUND TECHNOLOGY TEAM: WE ARE IN THE TUNNEL AND MINE WITH YOU FROM THE START TO THE END OF THE JOB

MAPEI's Underground Technology Team (UTT) delivers innovative and sustainable solutions tailored to the unique demands of underground construction work. Our dedicated team comprises polymer chemists, material scientists, civil and mining engineers, and highly skilled technicians for laboratory and on-site support.

In addition to the regular construction challenges faced on above-ground jobsites, each underground job features additional unique challenges due to the often-severe locations. MAPEI's UTT group was established to address these demands, partnering with clients from project inception through testing, implementation, and ongoing support as needed. Our solutions and products are the creation of permanent industry needs. We collaborate and exchange ideas with our clients, such as conditions and application particularities, material properties, and sustainable business development. We integrate all aspects into the final formulation to deliver high-performance results.

From the project specification, to the admixtures for shotcrete and concrete, to the final protective coatings, MAPEI's UTT group and technologies are there for the whole job. The UTT group is a successful division of MAPEI Group, which has provided proven construction system solutions for more than 85 years.

Established in 1937, MAPEI Group is a global corporation based in Milan, Italy, and includes 98 subsidiaries that comprise 106 plants in 59 countries. MAPEI is a world-leading manufacturer of mortars, grouts, and adhesives, as well as complementary products for installing floor and wall coverings. MAPEI manufactures chemical products for building, including waterproofing products, admixtures for concrete and repair products, and decorative and protective exterior coatings, as well as the UTT product line.

The UTT corporate group was established in 1999 and has successfully developed solutions and products since then. The UTT group in the United States started in earnest in 2015, and the business has grown substantially since then, enlarging the team and capabilities. In the underground industry, safety and speed are essential — not only for the products themselves, but also of the evolution of technology. MAPEI reinvests a significant portion of its annual profits in research and development (R&D) to maintain a leading technological advantage, dedicating 5% of total turnover to innovation and product development. MAPEI's commitment to R&D ensures that the UTT line comprises innovative and technologically advanced products that the UTT team is trained to use and implement to the end user with great satisfaction.

The UTT product line is divided into seven categories:

- Concrete technologies include more than 70 products, ranging from superplasticizers, accelerators, and retarding agents to accessory products dedicated to every type of underground concrete application, including shotcrete, ready-mixed concrete, and precast concrete.
- Injection, consolidation, and anchoring products consist of a complete range of ready-to-use cementitious mixtures, chemical mixtures, and chemical resins designed for underground injection into rock, soil, and concrete structures. These products help to stop water leaks and improve soil properties, internal cohesion, and anchorage.
- Waterproofing systems feature a wide range

of waterproofing options, including synthetic geomembranes and spray-applied membranes for all moisture conditions.
- Renovation, maintenance, and repair technologies include products for repairing concrete, fireproofing mortars, equipment for ready-to-use shotcrete, and injected products.
- Coatings for underground construction include protective paints, cementitious mortars, and ceramic coatings.
- Mechanized tunneling offerings from UTT encompass a range of products and on-site technical assistance services to support clients throughout tunneling projects, from start to finish.
- Mining solutions are provided for a quickly changing industry, focusing on sustainability and high-end technology to become more efficient and competitive for current and future generations.

No matter the division or the product line, MAPEI is known for quality products and for providing system solutions. The distinguishing point for UTT is the field support and applied technology in the field. Simply put, UTT doesn't just sell a product, but rather goes into the field and helps customers use the products — on their jobsite, with their conditions, personnel, and equipment. UTT services a project from the very beginning to the very end like no one else in the industry does. MAPEI also has the agility to adjust to the customers' needs when necessary.

CONTACT INFORMATION:

MAPEI Underground Technology Team

utt.mapei.com/en/products

1144 E. Newport Center Dr.,
Deerfield Beach, FL, 33442

p.collins@mapei.com

MAPEQUICK alkali-free accelerators are used to achieve rapid setting and fast strength development.

MAPEI's UTT group offers unmatched field support.

CORPORATE MEMBER PROFILE

Engineering & Construction Innovations, Inc.

Engineering & Construction Innovations (ECI) is a recognized leader in complex civil and geotechnical construction solutions. As an ASA Corporate Member, ECI is proud to contribute deep technical expertise in structural shotcrete to infrastructure projects across the Midwest. From slope stabilization to shaft and tunnel applications, ECI's shotcrete crews bring industry-best safety and innovation to every job.

SHOTCRETE CAPABILITIES & INNOVATION

ECI specializes in wet-mix shotcrete placement with a strong emphasis on robotic placement, overhead application, and confined-space execution. While the company doesn't claim proprietary methods, our team is nationally recognized for rare and technically demanding work as exemplified by one project where we site-batched and pumped concrete 2300 ft (700 m) down into a mine shaft, followed by overhead shotcrete placement.

The firm frequently integrates shotcrete with systems like ground freezing, lattice girders, and slope stabilization techniques. Every shotcrete project is supported by ACI-certified shotcreters, rigorous quality control, and a 100% safety compliance record to date.

PROJECT HIGHLIGHTS

10TH AVENUE WATER MAIN CROSSING – MINNEAPOLIS, MN

On this project for the City of Minneapolis, ECI used reinforced shotcrete as the primary shaft liner within a 30-ft (9 m) diameter, 80-ft (24 m) deep shaft constructed in conjunction with ground freezing. The shaft concrete was shotcreted using remotely manipulated nozzling equipment.

10th Avenue Water Main Crossing in Minneapolis, MN: Crews place shaft shotcrete using a remotely manipulated nozzle arm.

10th Avenue Water Main Crossing in Minneapolis, MN: Slope stabilization is achieved using hand nozzling for shotcrete placement.

Soudan Mine Shaft Rehabilitation in Soudan, MN: 2300 ft underground, crews used shotcrete placement in one of Minnesota's deepest mine shafts. Zero incidents. Total precision.

Lake Elmo West Connection in Lake Elmo, MN: Crews utilize shotcrete placement and lattice girders as a structural liner for the microtunnel receiving shaft.

Slope stabilization shotcrete was placed by hand nozzling for enhanced safety and efficiency.

LAKE ELMO WEST CONNECTION – LAKE ELMO, MN

As part of an interceptor extension, ECI installed a lattice girder and shotcrete shaft lining system to stabilize deep excavations for microtunnel launch structures. The team's shotcrete work ensured structural integrity in high-traffic, utility-dense areas, minimizing disruption and delays.

RAMSEY COUNTY JAIL (WEST PUBLISHING DECONSTRUCTION) – ST. PAUL, MN

In an urban rock bluff setting, ECI employed shotcrete with rock anchors to stabilize slopes and excavations during the deconstruction of the former West Publishing site. The combination of access-challenged terrain and structural sensitivity made this a prime example of shotcrete adaptability.

SOUDAN MINE SHAFT REPAIRS – SOUDAN, MN

At a depth of 2300 feet, ECI site-batched and direct-pumped concrete for sloped overhead shotcrete placement inside one of Minnesota's deepest mine shafts on two different projects — once in 2010, and again in 2022. This logistically complex project was completed from elevated platforms in confined spaces with zero incidents and full safety compliance.

TRAINING, CERTIFICATION & SAFETY

ECI maintains a crew of ACI-certified shotcreters, and all shotcrete operations are led by highly experienced foremen and superintendents. Projects regularly require confined-space and elevated-platform work, supported by a strong safety culture and continuous training. The company boasts a zero-incident record on all shotcrete work to date.

LOOKING AHEAD

As demand for technically advanced concrete solutions grows, ECI continues to lean into its strengths in wet-mix shotcrete and remotely manipulated nozzling equipment, and always focusing on integrating new technologies and methods. With a commitment to safety, quality, and execution under pressure, ECI remains at the forefront of structural shotcrete innovation in the U.S. market.

CONTACT INFORMATION:

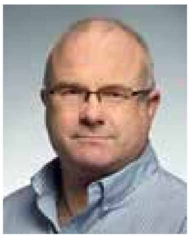
Engineering & Construction Innovations, Inc.

eciconstructors.com

7002 6th St. N, Oakdale, MN 55128

651-298-9111

2025 Carl E. Akeley Award



Andy Thompson

The 20th annual Carl E. Akeley Award was presented to Andy Thompson for his article, "Shotcrete as Final Liner — Design Considerations," which was published in *Shotcrete* magazine, Volume 27, Number 3, 3rd Quarter 2025.

The article discusses how shotcrete (often called sprayed concrete) is increasingly used worldwide as the permanent final lining for underground structures due to its flexibility in forming non-uniform shapes and eliminating complex formwork. This can improve construction logistics, reduce costs, and accelerate schedules. While shotcrete is primarily a placement method and does not fundamentally change the structural design of a reinforced concrete lining, its use introduces specific design, specification, and quality control considerations.

Key initial considerations include compliance with governing codes and standards, which can significantly influence where and how shotcrete may be used. Shotcrete is often employed both as initial ground support and as the permanent lining, typically in conjunction with rock bolts, lattice girders, mesh, or steel fibers. Initial linings resist short-term ground and construction loads, while permanent linings address long-term ground, hydrostatic, thermal, and shrinkage effects, as well as operational loads and fire resistance where required.

Design commonly relies on 2D and 3D numerical modeling to capture ground/structure interaction and time-dependent strength development. Waterproofing systems play a critical role: Sheet membranes usually limit composite action between linings, while spray-applied membranes may allow it if long-term bond performance is demonstrated. Surface smoothness and preparation are essential to protect membranes and ensure durability.

Final lining designs must consider constructability, including reinforcement congestion, layer thickness, and whether hand-sprayed or robotic application is used. Alternatives such as steel fiber-reinforced shotcrete can simplify reinforcement but demand high workmanship and rigorous quality control. Case studies, notably New York's East Side Access project, illustrate how local codes can restrict reinforcement layouts yet allow flexibility through preconstruction testing and mockups.

Safety is a major concern in overhead shotcrete placement. Exclusion zones, early-age strength testing, and detailed construction planning are critical to preventing accidents. Ultimately, successful use of shotcrete as a final lining depends on integrating code compliance, design detailing, testing, quality assurance, and safety into a coordinated project approach.

Scan or click the QR code to read the full article.

AKELEY AWARD HISTORY

ASA established the Carl E. Akeley Award in 2005 to honor his founding of what is today referred to as the shotcrete process. This award is presented to the author(s) of the best technical article appearing in Shotcrete magazine in the past 12 months, as determined by the Akeley Award Committee of ASA.

Carl E. Akeley invented the cement gun in 1907 and introduced a commercial version of it at the Cement Show in New York in December 1910. For this reason, Akeley is considered the inventor of the shotcrete process.[1]

Born in Clarendon, NY, on May 19, 1864, Akeley was a noted naturalist, taxidermist, inventor, photographer, and author. He made many significant contributions to the American Museum of Natural History and many other museums around the United States. He initially invented the cement gun to repair the façade of the Field Columbian Museum and later used it to improve the quality of his taxidermy exhibits at the museum. Akeley made five expeditions to Africa, during which time he procured many animals for museum exhibits. President Theodore Roosevelt accompanied him on one of those expeditions and encouraged him in his development of the cement gun. During his fifth expedition to Africa, he contracted a virus and died on November 17, 1926.

ASA MEMBERS! READY TO JOIN A COMMITTEE?

There's an easy way to do that! Visit **shotcrete.org**, click My ASA in the top-right navigation bar, and log in with your username and password. Once you have logged in, you will see a list of committees; click the 'Request' button to notify the committee chair that you're interested in becoming a member of their committee. You will be contacted by the chair once they have reviewed your request.

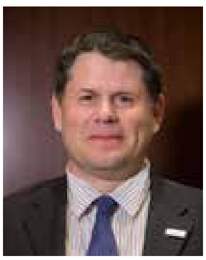
My ASA

PAST AKELEY AWARD RECIPIENTS

- 2024—C. Poulin and M. Jolin, “A Study on Low-Velocity Sprayed Mortars”
- 2023—R. Bracamontes, “The Use of Rapid-Set Accelerators in Shotcrete”
- 2022—Program Paused
- 2021—O. Duckworth, “Slump—The Most Misunderstood Characteristic of Wet-Mix Shotcrete”
- 2020—A. Gagnon, M. Jolin, and J. D. Lemay, “Performance of Synthetic Sheet Waterproofing Membranes Sprayed with Steel Fiber-Reinforced Shotcrete Testing for Waterproofing Membrane Integrity After Spraying.”
- 2019 – W. Clements and K. Robertson, “Compatible Shotcrete Specifications and Repair Materials”
- 2018—K. Yun, “Cellular Sprayed Concrete”
- 2017—A. Nitschke, “Modeling of Load-Bearing Behavior of Fiber-Reinforced Concrete Tunnel Linings”
- 2016—M. von der Hofen, “East End Crossing”
- 2015—E. Yurdakul and K.-A. Rieder, “Effect of Pozzolanic-Based Rheology Control Agent as a Replacement for Silica Fume”
- 2014—L. Zhang, “Variability of Compressive Strength of Shotcrete in a Tunnel-Lining Project”
- 2013—Jolin, Nokken, and Sawoszczuk, “Sustainable Shotcrete Using Blast-Furnace Slag
- 2012—R. C. White Jr., “Pineda Causeway Bridge Rehabilitation”
- 2011—C. S. Hanskat, “Shotcrete Testing—Who, Why, When, and How”
- 2010—L. Zhang, “Is Shotcrete Sustainable?”
- 2009—Dufour, Lacroix, Morin, and Reny, “The Effects of Liquid Corrosion Inhibitor in Air-Entrained Dry-Mix Shotcrete”
- 2008—E. S. Bernard, “Embrittlement of Fiber-Reinforced Shotcrete”
- 2007—K. F. Garshol, “Watertight Permanent Shotcrete Linings in Tunneling and Underground Construction”
- 2006— Dufour, Reny, and Vézina, “State-of-the-Art Specification for Shotcrete Rehabilitation Projects”

President's Award 2025

A highlight of an ASA President's responsibilities is to nominate a distinguished member for ASA's President's award. Since 2005, this award has recognized 19 individuals and an organization that have made exceptional contributions to the shotcrete industry. It is among ASA's highest honors and is the responsibility and honor reserved for the immediate outgoing President. This year that mantle falls upon Bill Geers.



Raúl Bracamontes
Bracamontes Consulting LLC

It is the sole responsibility of each previous year's American Shotcrete Association (ASA) President to select the recipient of the President's Award as a final act before leaving the office. Since 2006, numerous well-deserving individuals and one organization have been awarded the ASA President's Award, all of whom dedicated their time and energy to advance the shotcrete industry. At the completion of my tenure as President, I am honored to be presenting the ASA President's Award to a person clearly deserving of this esteemed recognition: I am presenting this year's President's Award to Raúl Bracamontes, for his outstanding service to the ASA and the shotcrete industry.

This year's recipient has been a consistent force of inclusion in the shotcrete community to our Spanish speaking segment. As an engineer, author, speaker, ACI-certified shotcreter, ACI-certified shotcrete inspector, and an ASA/ACI shotcreter examiner, Raúl Bracamontes has played a key role in bringing ACI materials and certification, along with ASA presentations and information, to the Spanish speaking shotcrete community for decades.

Raúl has gained an international reputation for his insights and training in shotcrete placement. He has written 12 books (including two cookbooks) and traveled to numerous countries to consult, train, and present on shotcrete-related projects and topics. He has conducted the lion's share of bilingual shotcreter certification sessions in the U.S. and Canada on ASA's Roster of examiners. Raúl has reviewed and translated most of the ACI Shotcreter Certification study materials (ACI CCS4 and CP 60). Additionally, his support for the certification program included reviewing translated exam materials and certification exam questions (wet- and dry-mix written) for accuracy.

Raúl is active on ASA's Education & Safety Committee, as well as the Underground Committee. He has contributed to work products such as ASA's Safety Guidelines for Shotcrete, position statements, and many articles for Shotcrete magazine. In 2023, Raúl was the recipient of ASA's Carl Akeley Award for his article on "The Use of Rapid-Set Accelerators in Shotcrete." Raúl also serves as the translation editor behind ASA's Spanish articles in each issue, allowing ASA to provide articles of interest to our Spanish speaking shotcreters in each issue.

There are numerous ways Raúl has contributed to ASA's community, but what stands out most is his humble willingness to serve whenever he is asked and as quickly as he can, despite a very heavy travel schedule. Aided by his master scheduler wife (who can match him in creativity when scheduling and organizing Raúl's engagements), Raúl will always try his best to fit any request into his schedule. He has a great sense of humor, puts attendees at ease, and conducts himself professionally in every setting. Raúl is someone you want on your team — he is someone who cares, works with excellence, and follows through with his commitments. That is why I'm proud to present Raúl Bracamontes as my choice for this year's President's award.

ASA'S QCP PROGRAM GOING STRONG!

ASA's Contractor Qualification program is now in its 7th year! The first rounds of Qualified Contractors reached their 5-year milestone and successfully renewed their credentials. The program, application, and review process have been refined, and the program is gaining traction and interest, especially in the pool market.

After the program's initial launch in 2019, the committee quickly recognized the need for better guidance for project owners in the pool industry, especially as the COVID-19 pandemic drove unprecedented demand for residential pools and flooded the market. The demand drew many inexperienced contractors into the field to help meet those needs. Unfortunately, the inexperience and lack of knowledge regarding quality shotcrete placement threatened to undo decades of work to rebuild the reputation of shotcrete as a structurally sound method for concrete placement.

The ASA Contractor Qualification Committee worked closely with ASA's Pool & Recreational Shotcrete Committee to adapt the CQ application and program requirements to accommodate a Qualified Contractor for Pools (QCP) credential. The QCP was launched last year and now welcomes Top Gun of Virginia Inc, who successfully completed their application, adding the newly established Qualified Contractor – Pools (QCP) to their credentials! Congratulations!

The CQ logo was adapted to reflect these changes, creating two new CQ logos and corresponding Hard Hat stickers to better represent each program.

Our Qualified Contractors are listed on ASA's main Certification and Qualification page: **https://shotcrete.org/certification-qualification/** and now also in the Pool Portal (**pools.shotcrete.org**) and Structural Portal (**structural.shotcrete.org**), respectively. This year, ASA will continue to launch more resources to promote and support ASA Qualified Contractors. Stay tuned!

SAFETY GUIDELINES FOR SHOTCRETE NOW AVAILABLE!

The 2025 update of *Safety Guidelines for Shotcrete* is now available in both English and Spanish! You can view it in a secured PDF format in one of two ways:

- **Sustaining and Corporate Members:** Visit **shotcrete.org**, log in to *MyASA*, select your *Sustaining and Corporate Members* group, and download your complementary copy of *Safety Guidelines for Shotcrete* under 'Recent Documents'.
- **All Others:** Visit the bookstore at **shotcrete.org/bookstore** to purchase your copy of *Safety Guidelines for Shotcrete* today!

PLEASE WELCOME OUR 2026 LEADERSHIP!

Our 2026 American Shotcrete Association Officers and Board of Directors were elected with no alternatives submitted.

ASA Officers

- President: Jason Myers | Dees-Hennessey Inc
- Vice-President: Kevin Robertson | Sika Corporation USA
- Secretary: Bruce Russell | CROM LLC
- Treasurer: Derek Pay | Oceanside Construction
- Past President (non-elected): Bill Geers | Solomon Colors Inc

New ASA Directors (3-year terms)

- Mark Bradford | Spohn Ranch Skateparks (2nd 3 yr term)
- Justin Shook | Baystate Shotcrete LLC (2nd 3 yr term)
- Mike Cetnar | ConForms (1st 3 yr term)

New ASA Director (2-year term)

- Andy Thompson | Mott MacDonald (filling Derek Pay's remaining 2 yr)

Returning ASA Directors

- Randle Emmrich | Coastal Gunite Construction Company (1 yr remaining)
- Christoph Goss | Schnabel Engineering (1 yr remaining)
- Jake Wiseman | Wiseman Shotcrete (1 yr remaining)
- Jamie Curtis | CCP Shotcrete & Pumping (2 yrs remaining)
- Mike Klemp | Thorcon Shotcrete & Shoring LLC (2 yrs remaining

NEW ASA MEMBERS

SUSTAINING

Consel Construction Specialty Services, Inc.
Fort Myers, Florida
conselinc.com
Primary Contact: Stanton Cromer
secromer@conselinc.com

RAM Construction Services
Livonia, Michigan
ramservices.com
Primary Contact: Dan Canedo
dcanedo@ramservices.com

Madison Concrete Construction
Malvern, Pennsylvania
madisonconcrete.com
Primary Contact: Jim Dolente Jr.
jdolentejr@madisonconcrete.com

MacLean Engineering
Collingwood, ON, Canada
macleanengineering.com
Primary Contact: Jakob Van de Sande
jvandesande@macleanengineering.com

INDIVIDUAL

Felix Delgado Ponte
Chillia, Pataz, Peru

John Davis
F & W Construction
Santa Rosa Beach, Florida

Tommy Kirl
Precision Pools Inc
Longview, Texas

ACADEMIC

Elsa Defforey
Laval University
Québec City, QC, Canada

SUSTAINING CORPORATE ASSOCIATE

Michael Donovan
Consel Construction Specialty Services Inc
Fort Myers, Florida

Stephen Suever
Consel Construction Specialty Services Inc
Fort Myers, Florida

Todd Reynolds
Consel Construction Specialty Services Inc
Fort Myers, Florida

Anthony Zanni
RAM Construction Services
Livonia, Michigan

Tom Szabo
RAM Construction Services
Livonia, Michigan

Zach Ellis
RAM Construction Services
Livonia, Michigan

Rick Stone
Madison Concrete Services
Malvern, Pennsylvania

Rob Ferguson
Madison Concrete Services
Malvern, Pennsylvania

Stephen Dolente
Madison Concrete Services
Malvern, Pennsylvania

Jonathan Lavallee
MacLean Engineering
Collingwood, ON, Canada

Joseph Macias
MacLean Engineering
Collingwood, ON, Canada

Tara MacLean
MacLean Engineering
Collingwood, ON, Canada

CORPORATE

Texas Shotcrete, Inc.
McKinney, Texas
texasshotcrete.com
Primary Contact: Todd Capley
todd@texasshotcrete.com

Axis Shoring & Drilling Ltd.
Victoria, BC, Canada
axissd.com
Primary Contact: Dustin Krizsan
dustin.krizsan@axissd.com

Summit GeoStructures
Lindon, Utah
summitgeostructures.com
Primary Contact: Jesse Friel
jdfriel@summitgeostructures.com

Pumpmaster Inc
Potrero, California
thepumpmaster.com
Primary Contact: Myron Rick
gwponr@mac.com

McGill Restoration Inc
Omaha, Nebraska
mcgillrestoration.com
Primary Contact: Ben Russell
brussell@mcgillrestoration.com

Superior Gunite
Sylmar, California
shotcrete.com
Primary Contact: Nick Hacopian
nick.hacopian@shotcrete.com

Nesbou Shoring
North Vancouver, BC, Canada
nesbou.com
Primary Contact: Amir Khajehmogahi
amir@nesbou.com

asa Sustaining Corporate Members

Thank you, Sustaining Corporate Members, for your investment in the industry! ASA Sustaining Corporate Members show true dedication to ASA's vision to see "structures built or repaired with the shotcrete process accepted as equal or superior to cast concrete." These industry leaders are recognized for their exemplary level of support for the Association in a variety of ways.

REED Shotcrete Equipment
www.reedpumps.com

CanCrete Equipment Ltd.
www.cancrete.ca

Curtis Concrete Pumping
www.curtisconcretepumping.com

R-E-D Industrial Products
www.redindustrialproducts.com

Consel Constrution Specialty Services, Inc.
www.conselinc.com

Coastal Gunite Construction Company
www.coastalgunite.com

Thorcon Shotcrete & Shoring LLC
Thorconshotcrete.com

Consolidated Shotcrete Inc.
www.consolidatedshotcrete.ca

Ocean Rock
www.oceanrockart.ca

Construction Forms
www.ConForms.com

Nationwide Shotcrete Inc
www.nationwideshotcrete.com

MacLean Engineering
www.macleanengineering.com

Geo-Rope Ltd. (Canada)
www.geo-rope.com

MAPEI Underground Technology Team
www.utt-mapei.com

PULLMAN
www.pullman-services.com

Saffo Contractors Inc.
www.saffocontractors.com

Western Shotcrete Equipment
www.wseshotcrete.com

COST of Wisconsin Inc.
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