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Outstanding Shotcrete Project Awards

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shotcrete MAGAZINE

Volume 22, Number 1 • Winter 2020

FEATURES

Shotcrete is a quarterly publication of the American Shotcrete Association. For information about this publication or about membership of the American Shotcrete Association, please contact ASA Headquarters at:

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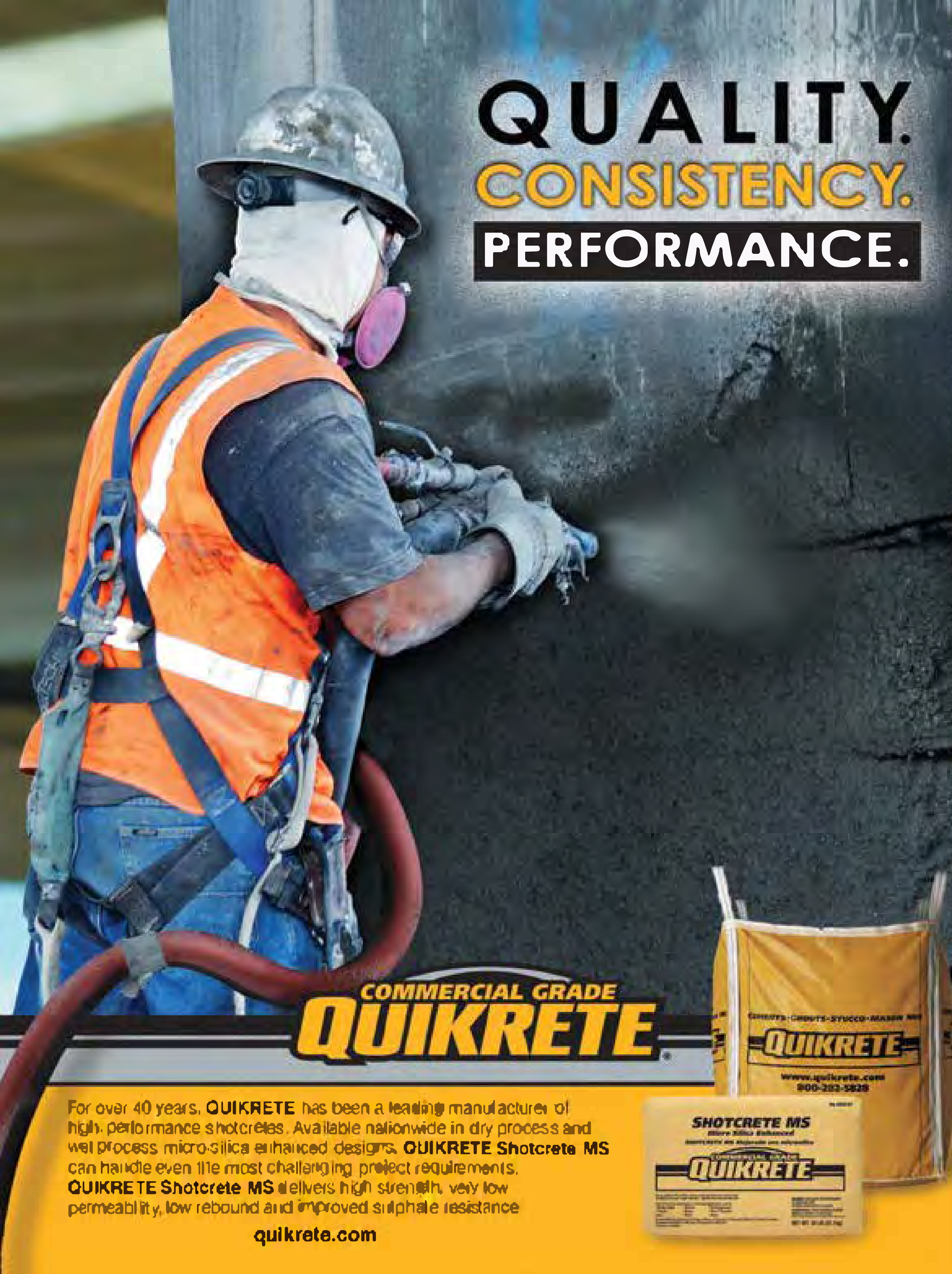
The opinions expressed in *Shotcrete* are those of the authors and do not necessarily represent the position of the editors or the American Shotcrete Association.

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).

ALSO FEATURING

DEPARTMENTS

On the cover: Ayla Golf Academy and Clubhouse in Aqaba, Jordan. Photo courtesy of Rory Gardiner. Read about this project on page 44.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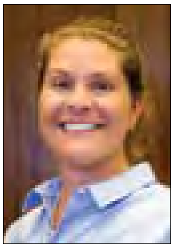
Gratitude to ASA and its Membership

By Cathy Burkert



The time has come for the next ASA President to take over the reins. My time leading ASA has been interesting with some distinct challenges and successes. I am proud to have served all of you. I have been very fortunate to work with the committee chairs, active committee members, Board of Directors, and staff of ASA to achieve many things this past year including:

- Shotcrete directly included in the ACI 318-19 Building Code Requirements for Structural Concrete;
- Completed the rollout of the ASA Shotcrete Contractor Qualification program;
- Significantly increased our outreach to owners and specifiers with over 1500 attendees at over 40 separate seminars or presentations;
- Fielded an outstanding group of nominations for the Outstanding Shotcrete Project Awards program; and
- Continued as the primary sponsoring group for the ACI Shotcrete Nozzleman Certification program administering 81 sessions with over 500 certifications.

As I reflect on my time as a member, a committee chair, a

"...I am nothing short of grateful for all that I have learned from all of you along the way."

participant on many committees, a member of the Board of Directors, and serving on the Executive Committee for many years until becoming President, I am nothing short of grateful for all that I have learned from all of you along the way. You have made me who I am today, and I am most grateful for the resources that ASA members provide. I am so proud of ASA and its mission, accomplishments, and the army of volunteers that make us who we are. Our Association has so much diversity of gender, race, age, professions, and experience—which is at times overwhelming, but that is what makes us so strong. Different personalities and strong opinions can prove challenging to bring together, but what's most rewarding is to see that despite our differences, we are all united for the same goal—to promote shotcrete!

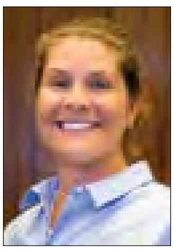
As I began my adventure at the ASA meetings in 2005, I was immediately impressed by the number of members that took me under their wing and provided me with guidance in my shotcrete career. While I wish I had this entire magazine to personally thank all of you individually, we don't want this column to consume the entire issue. So, if you are reading this and I have worked alongside you, please know how much I thank you for the effect you have had on me.

While I know we may have had some disagreements and perhaps there was a time at a meeting, on a conference call, or in an e-mail chain that may have gotten heated, please know that our strong opinions and differences are what makes this Association so powerful. We all come from different backgrounds—as engineers, contractors, manufacturers, suppliers, educators, and students. The perspectives each individual brings to how we shape and move ASA forward is essential.

I look forward to continuing serving ASA as Past President as well as on several of our committees to help promote the Association. I truly believe in and fully support what ASA stands for. I encourage all of you that are considering membership and joining us at the committee meetings, to just do it! The education, networking, and resources you will receive in joining with us will benefit you, your career, and your company for a lifetime. Finally, as ASA brings so many like-minded people together, you will also undoubtedly develop lasting friendships that you will relish and appreciate throughout your involvement with ASA and beyond.

Marketing Committee

By Cathy Burkert



The Marketing Committee has been busy this past year and we welcomed new members Ed Brennan, Kevin Robertson, and Jason Myers. We are excited that we presented shotcrete seminars to more than 1500 people at over 40 presentations nationwide, including the ASA Shotcrete Inspector educational course and ASA Shotcrete Contractor seminars. To learn more about ASA education opportunities, visit **www.shotcrete.org/education**.

ASA recently returned to Las Vegas, NV, for the annual ASA Awards Banquet held in conjunction with World of Concrete (WOC). As a long-time co-sponsor of WOC, ASA exhibited, and we hope you had the opportunity to visit our booth. ASA is currently gearing up to host its 2021 Shotcrete Convention & Technology Conference at Sonesta Resorts in Hilton Head, SC.

ASA has been active on social media sites such as Facebook, Instagram, LinkedIn, and Twitter. We encourage you to follow ASA and its social media pages to receive the latest news and ASA updates.

The Marketing Committee has been working to create an updated shotcrete video illustrating the different placement methods of shotcrete, including preparation, finishing, and the finished product for both wet- and dry-mix shotcrete. A call for videos and guidelines for submitting video clips will be sent to the ASA membership soon. We encourage all members to submit quality videos of their work to be part of this great compilation which will be available online and played at all the tradeshows ASA attends.

ASA MARKETING COMMITTEE

Cathy Burkert, Chair | American Concrete Restorations, Inc.
Ashely Cruz, Secretary | Cruz Concrete & Gunite Repair Inc.

Ed Brennan | U.S. Concrete Products LLC
Oscar C. Duckworth | Valley Concrete Services
Randle M. Emmrich | Coastal Gunite Construction Company
Patrick Bridger | King Shotcrete Solutions
Joe Hutter | King Shotcrete Solutions
Tom Norman | Gunite Supply & Equipment Co.
Ryan Poole | Consultant
Kevin Robertson | King Shotcrete Solutions
Raymond Schallom III | RCS Consulting & Construction Co. Inc.
Ted Sofis | Sofis Company Inc.
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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.

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Advancing Shotcrete into a New Decade

By Charles S. Hanskat, PE, FACI, FASCE, ASA Executive Director

As we look back on our achievements of 2019, they give rise to expecting even greater progress by ASA on a variety of topics that help accelerate the adoption of shotcrete placement in concrete applications.

In 2019, we presented seminars or sessions about the value and creativity of shotcrete at 46 events in North America. At these sessions, we reached over 1500 attendees, many who—before the session—knew little about shotcrete or may have had misconceptions about what shotcrete was and what it could do. In 2020, we already presented at the annual Transportation Research Board and held a regional Shotcrete Inspector Education program in the Washington, DC, area.

In 2019, we coordinated and staffed 81 shotcrete nozzleman certification sessions, resulting in 542 certifications. Although not quite as many sessions or certifications as our 2018 record year, it was the second largest volume of certifications in our history. Sixty percent of the total were new full or nozzleman-in-training certifications—so the good news is, we are seeing new nozzlemen enter our workforce. This is essential, as we need to have the experienced people available to meet the demand. In 2020, we expect more demand for shotcrete, because the new version of ACI 318 directly includes shotcrete as a placement method for structural concrete.

In 2019, we finalized our ASA Shotcrete Contractor Qualification program. Although only three companies completed the process in 2019, we expect many more will see the value and distinction that becoming an ASA Qualified Shotcrete Contractor gives to a shotcrete company. At World of Concrete in February 2020, we had excellent attendance at our Shotcrete Contractor Education program, which is a prerequisite for a company pursuing the ASA qualification.

In 2019, our committees displayed a new level of activity and involvement by our volunteer members. You'll find a list of all our officers and committee chairs on the left side of the table of contents in this issue of *Shotcrete*. Both the Underground and Pool & Recreational Shotcrete Committees generated position papers that help set the standard in their respective industries. The Safety Committee finalized a new Shotcrete Safety presentation that is focused on providing our Corporate Members an educational program they can use for their field crews and project managers. The Contractor Qualification Committee refined the process for company applications and reviewing of the applicant's qualifications that allowed us to offer the program with competence and integrity. The Marketing Committee is actively improving our informational videos and providing input on our social media, even considering an ASA podcast. The Membership Committee is closely tracking our efforts to bring in new members and retain existing members along with providing input on our upcoming convention in early 2021. The Board of Directors, and especially our Executive Committee, have been highly involved and helped us deal with the challenges introduced by the transition to a new association management company as well as providing oversight on the day-to-day operation of our Association by our staff. In 2020, we see no let down in the activities of our committees, and with their diligent work, expect an increase in the visibility, acceptance, and credibility of our Association in the concrete construction world.

In 2019, we made significant inroads in various codes and standards that cover shotcrete. The ACI 318-19 inclusion of shotcrete was a major milestone. Future versions of IBC will use the ACI 318 provisions to replace their outdated code requirements. We also made headway in helping to improve shotcrete coverage in documents from AREMA, ASTM, and ICRI. In 2020, we should see ACI 301 covering shotcrete, and will work to improve shotcrete coverage in other pertinent concrete design and construction standards.

In 2019, we held our second ASA Shotcrete Convention in February in Amelia Island, FL. It was a great event and very well attended, bringing together members, exhibitors, and potential new members. The venue wasn't so large as to seem impersonal and conversely was very welcoming and friendly. We received very positive feedback from the attendees. Most recognized the networking opportunities, quality of the speakers, and events made them feel an important part of the shotcrete industry. Though we will not hold an ASA convention in 2020, we will be spending a lot of time and effort in setting up our 2021 Shotcrete Convention at the Sonesta Resort in Hilton Head Island, SC, February 21-23, 2021. Save the date!

Finally, in late 2019, we decided to move to a new association management firm. Though there are many details and challenges in moving from one firm to another we expect the new firm, Virtual, will provide ASA more flexibility and resources to allow our Association to grow while providing more service to our members and the industry. In early 2020, we will be completing the transition to the new firm. You can be assured our core staff, Assistant Director Alice McComas and I, continue to be fully dedicated to ASA and will work to make the transition as seamless as possible.

In all, 2019 was a great year. Yes, we had some distinct challenges and hurtles to clear. But, looking to the horizon, 2020 is shaping up to be even better for ASA and the shotcrete industry.

ASA GRADUATE STUDENT SCHOLARSHIP

2019-2020 Awardee

***Thomas Germain** is currently completing his master's degree in civil engineering at Université Laval in Québec City, QC, Canada. Originally from France, where he trained as a mechanical engineer at the Arts & Métiers school, Germain decided to pursue his education in Québec City in the field of civil engineering. His research project focuses on the reduction of rebound in shotcrete by better controlling the placement parameters of fresh concrete. This project is part of a larger project developed by Marc Jolin's Shotcrete Research Team, pursuing the objective of "Zero Rebound."*

MASTER'S RESEARCH PROJECT

Automation and Optimization of Shotcrete Placement Using a Robotic Arm

Shotcrete is an outstanding concrete placement technique and has seen, in recent decades, a number of improvements in mixture designs and equipment that have made it more popular than ever in fields such as mining, tunneling, repairs, and new construction. However, there is one drawback that is sometimes reported regarding the amount of rebound observed, whether it has to do with the mixture design, the shotcrete process, or difficult placement conditions. Building on the earlier work of graduates from the Shotcrete Laboratory at Université Laval, our knowledge of the composition, the properties, and the behavior of the spray of material has led us to believe rebound can be much better controlled and that equipment and placement techniques to achieve this need to be further explored.

The rebound reduction effort can roughly be put into three groups: shotcreting equipment, mixture design, and placement techniques. Indeed, most projects in the past have focused, with success, on mixture design and more recently on the behavior or description of the spray pattern.[1] However, very little attention has been given to the placement technique itself since the early publication from Crom in the 1980s.[2] This lack of research on the influence of placement methods on rebound has led us to take an active interest in it. Moreover, all can appreciate how placement technique is critical in obtaining high-quality shotcrete. Good materials placed poorly will produce an unsatisfactory final product.

Over the last few years, shotcrete placement has turned toward mechanically assisted applications: more hydraulic manipulators are used to prevent worker's exposure to potentially unstable shotcrete, unsupported ground, rebound, or dust. They can also help to increase productivity.

In parallel, the concrete industry has seen the development of ultra-high-performance concrete (UHPC) and some special fiber-reinforced concretes that along with some other high-performance materials can create resource efficient building elements.[3] Unfortunately, these materials are often developed for standard form-and-pour placement methods that are not always efficient and cost effective. Shotcrete placement opens up new possibilities to apply these special materials and use them to their full potential.

Keeping in mind these new high-performance materials, the need to further understand and control rebound, and the promising improvements to placement technique, the objective of this project was developed: To improve and optimize placement techniques through automation.

The first step of this project was to choose a way to automate shotcrete placement. By studying how other fields proceed, such as in the paint industry, the best and most exciting way to automatize shotcrete is by using fully controlled six-axis-robots. To come up with the most suitable solution, a specification chart was prepared to assure the robot would be compatible and able to handle the shotcrete placing equipment selected.

To operate the robot correctly, a suitable environment was essential. Different steps and system requirements had to be considered such as power supply, transportable mounting support, ground anchors, the tool to hold the nozzle, protective covers for high dust and wet environments, robot programming software, safety barriers, and sensors. This automated application of shotcrete must be transferable for use on future projects, so the design of the whole setup had to be reliable, flexible, and user-friendly. This portion of the project is completed. Sparo (Shotcrete Placement Automated by Robot) is now in the Shotcrete Laboratory; setup and initial programming is under way.

The second portion of the project is to create an automated shotcrete placement program to reduce rebound. For this, it has been decided to study separately the influence on the rebound of each parameter in nozzle movement: the spraying distance, the spray angle, the deposition rate, and the nozzle path. ACI 506, Guide to Shotcrete, recommends standard nozzle distances, angle, and placement techniques such as bench shooting or vertical layers.[4] The objective is to incorporate and optimize all this data into the research program to have an optimized shotcrete deposition efficiency.

This master's project intends to reduce rebound by optimizing placement parameters during fresh shotcrete deposition. In the future, it opens the possibility of a fully automated and smart application of shotcrete to create resource-efficient building structures with high-performance materials.

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The American Shotcrete Association sincerely thanks our Sponsors for their role in supporting the 2019 Awards Program!

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THANK YOU!

2019 Outstanding Architecture | New Construction Project

Architectural Shotcrete

By Adam Dobrowolski and Deane Hudson

In our lives, we seldomly look back and say, "that was a very cool project." This is one of those projects because of the challenges we faced from the start. Poor access, intricate finish, difficulty in formwork, concrete chemistry, and protection of the existing exterior façade were all challenges of the Uber Mission Towers Project.

THE PROJECT

Our project was to install the curved and sloping structural terrace walls with seats on the seventh floor of the two Uber Mission Towers Buildings at the New Chase Center in San Francisco, CA (Fig. 1). This project consisted of 3307 linear ft (1008 m) of curved planter walls ranging from 3 to 9 ft (1 to 3 m) in height, with a total of 455 yd^3 (348 m^3).

PROJECT CHALLENGES

When we first arrived on site, we immediately faced some unique challenges, such as the tower crane was gone, the exterior all glass façade was in place, and the waterproofing membrane was installed on seventh floor decks. As I stood and looked at the glass exterior from the courtyard, I thought—how will the team pull this off? As with every project Joseph J. Albanese, Inc. (JJA) performs, it all begins with a solid plan in preconstruction.

THE JJA PRECONSTRUCTION PROCESS

JJA's preconstruction process is a full team-integrated approach that occurs on every JJA project. From estimating, project management, virtual construction, and operations, team members combine talents and experiences to put together the best game plan to ensure success. Considering the unique nature of the walls themselves and overall setting of the outdoor terrace, JJA's in-house virtual construction team played a critical role—both for internal building efficiency and design coordination prior to JJA mobilizing (Fig. 2).

Though this project originally called for the walls to be constructed with the form-and-pour method, based on our experience and capabilities, we demonstrated the value of shotcrete placement to our client. It was obvious shotcrete was the best solution to achieve the vision the architect desired—namely concrete walls that both curved and sloped. Two additional benefits included the ability to improve schedule and to provide a vapor blast finish (a light sandblast with water/sand on steel trowel finish that results in an even, exposed sand finish).

LOGISTICS

After many considerations regarding access to the seventh-floor terraces, we decided on the following plan to logistically complete the project. First, all forming material would be hoisted to each terrace with a 150 ton (136 tonne) crane from the adjacent side streets. We would also hoist out all debris and forms after completing shoots at each tower with the same crane system.

Our second access concern was how to supply shotcrete to the seventh-floor roof terraces. Under typical site conditions, we would anchor slickline to an existing elevator

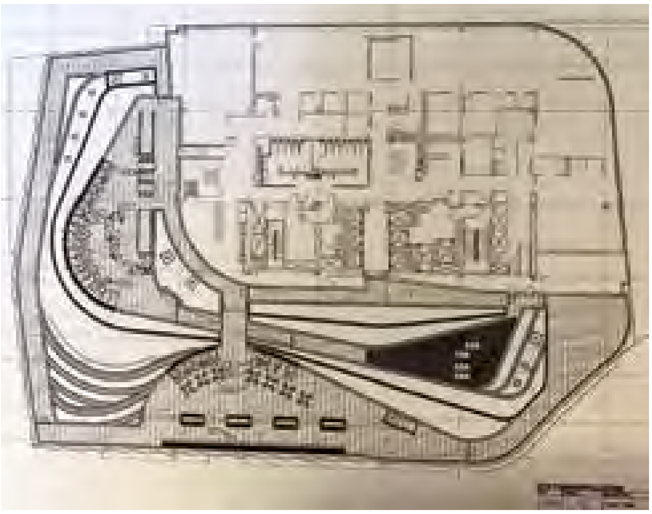

Fig. 1: North Tower plan

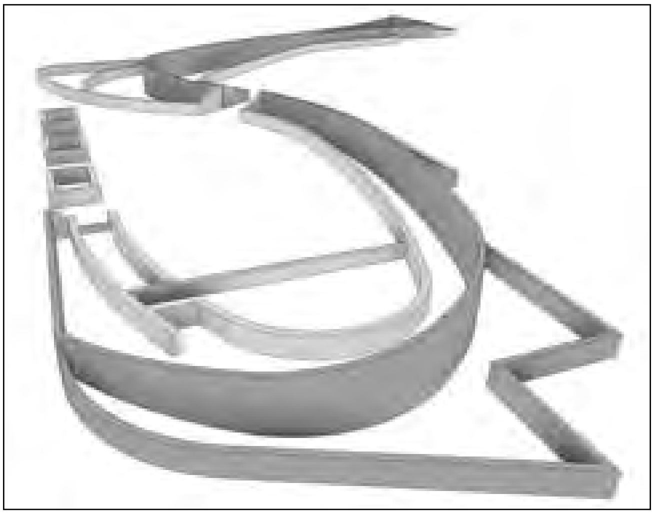

Fig. 2: BIM of project

Fig. 3: Self-supporting scaffold tower

opening, outside face of the building, or column line to the seventh floor, and then use rubber hose to service our work area. This was not possible with all floors, elevators, and exterior glass on the building already in place.

Our solution to getting shotcrete to the seventh floor was to set up a standalone scaffold to support the 3 in. (75 mm) slickline and our vapor blast material hoses. The scaffold system was engineered and installed by Bear Scaffold and Services from Alviso, CA. The design had a large footprint at the base, which was anchored to the ground, while the top of scaffold tower was anchored to the deck on seventh floor. The scaffold tower was approximately 10 ft (3 m) from the building. The overall height of the scaffold was 95 ft (29 m) (Fig. 3). We purchased new 3 in. slickline and heavy-duty clamps to ensure we had no issues with old slickline ruptures due to higher pumping pressures. The slickline was attached to the scaffold tower with new 3 to 2 in. (75 to 50 mm) swivel clamps, and JJA fabricated its own blowout box to clean out the system daily and keep it operating safely.

Once we figured out logistics, we self-performed all formwork and reinforcement over the existing waterproofing. After layout of the walls on waterproofing, a 6 in. (150 mm) strip of the waterproofing was removed and dowels installed at 36 in. (914 mm) on center at 4-1/2 in. (114 mm) embedment. We also laid the flutes out on top of the deck in front of the wall to avoid having to scan at each dowel location and to expedite layout.

Conclusions

As is typical with the construction industry, JJA's team faced challenges and circumstances through construction. It was JJA's field team's leadership (Superintendent Ismael Sandoval, Carpenter Foreman Jose Ramirez, and Shotcrete Foreman Anastacio "Tacho" Rivas) and solution-oriented attitudes, coupled with the leadership and team approach

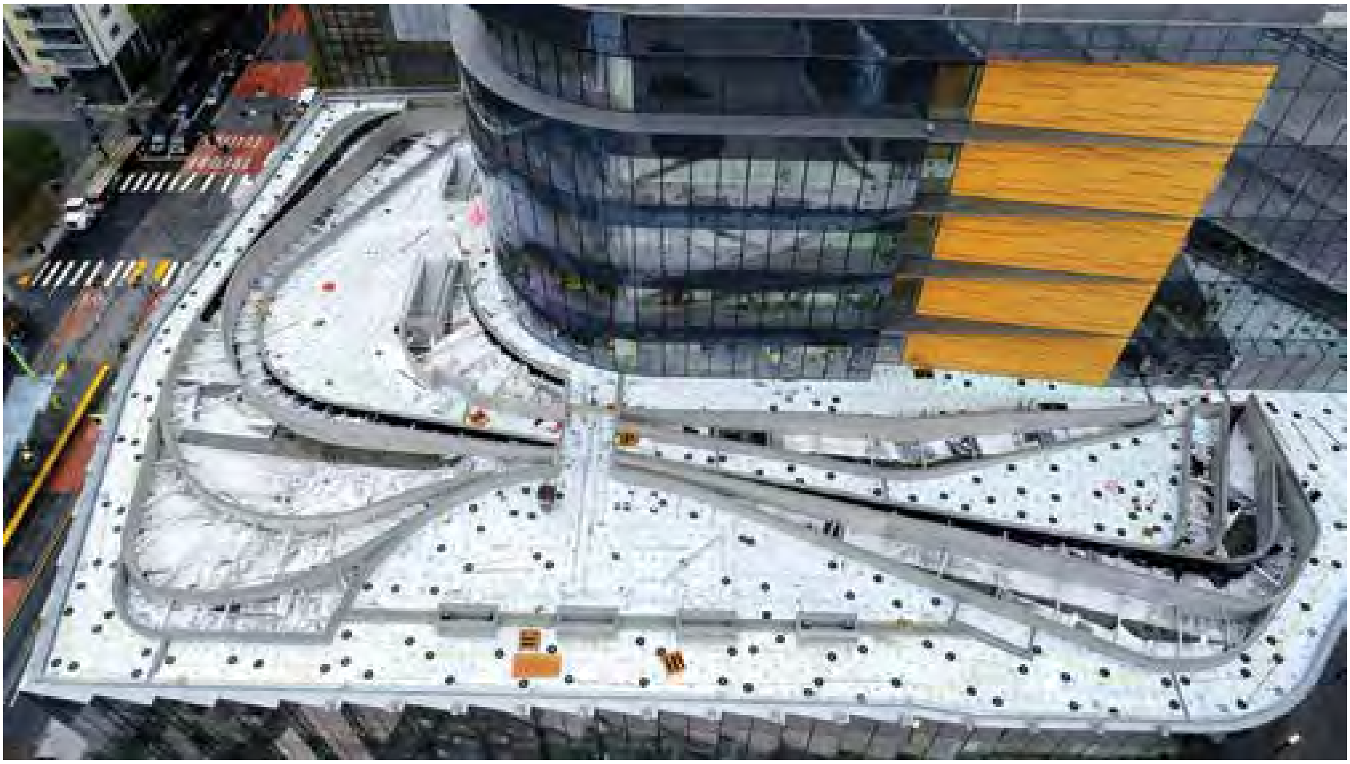

Fig. 4: Uber Mission North Tower

Fig. 5: Uber Mission South Tower

Fig. 6: Uber Mission Tower planter seats

of General Contractor DPR Construction, that ultimately pushed this project to finish safely and ahead of schedule.

JJA's tradesmen were able to demonstrate why JJA is an industry leader in shotcrete, and true to our core values, we were able to complete this high-quality project safely with zero safety incidents. JJA is proud of the finished product and is excited about the future architectural applications of shotcrete that we can perform for our clients! This was a very cool project!

2019 OUTSTANDING ARCHITECTURE | NEW CONSTRUCTION PROJECT

Project Name
Uber Mission Bay Tower Terraces

Location
San Francisco, CA

Shotcrete Contractor
Joseph J. Albanese Inc.*

General Contractor
DPR

Architect/Engineer
Huntsman Architectural Group, SWA Architects

Material Supplier/Manufacturer
Central Concrete – U.S. Concrete

Equipment Manufacturer
Reed Shotcrete Equipment*

Project Owner
Uber Technologies Inc.

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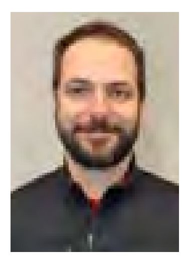

Adam Dobrowolski *is a Project Manager at Joseph J. Albanese, Inc. Originally from Chicago, IL, Dobrowolski used to spend his breaks from school performing interior and exterior renovations for homes. He graduated from the University of Illinois at Urbana-Champaign and moved to California in 2006 to work with his family's venture capital software company. After a few years, he decided that he wanted to get back into construction and joined the County of San Diego's Parks and Recreation department. During his time with the County, Dobrowolski served as a Project Manager executing capital improvement projects primarily in the East County, which included upgrading and renovating parks, constructing trails, constructing permanent County facilities, and serving as a liaison between community groups and the Board of Supervisors. In 2016, Dobrowolski moved to the Bay Area with his fiancé and joined the Joseph J. Albanese team, where he currently serves as a Project Manager with a primary focus in structural concrete, though he also has experience in demolition, grading, excavation, site concrete, shotcrete, and retrofits.*

Deane Hudson *is Joseph J. Albanese's Shotcrete Manager and oversees shotcrete production, quality control, and safety. Hudson is a powerhouse, equipped with over 28 years of shotcrete industry knowledge and experience. He is highly skilled in estimating, project management, supervising civil, underground, retrofit, and new construction projects. Hudson is a member of the American Shotcrete Association (ASA), the American Concrete Institute (ACI), and The Beavers Inc.*


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2019 Outstanding Infrastructure Project

Shotcrete in the Urban Jungle

By Jason Myers

In today's complex urban jobsite, easy sites to build on are diminishing, while available sites are becoming harder to reach. In addition, the remaining sites often require creative solutions to develop. The project 1395 22nd St. is a complex of five apartment buildings built into one of the many hillsides in San Francisco, CA, and is surrounded by existing buildings and adjacent properties. Several of the tallest buildings for the project have one level below grade, one level at grade, and ten stories above grade. As part of the foundation system of the project, horizontal and vertical grade beams were installed along the hillside for the first five stories of the buildings and then anchored into the hillside with prestressed tiebacks. The excavated slope was up to a 1.5:1 slope, making for very difficult access to each of the grade beams. Each of the first five floors of the project were anchored into the hillside by the placement of the floor slabs onto the grade beams, which were over 550 ft (167 m) long and positioned as much as 75 ft (22.8 m) up the slope. A typical grade beam was around 3 ft (0.9 m) square, but some of the grade beams included larger footings that were 3 ft deep and up to 5 ft (1.5 m) across. The volume of concrete for the grade beams was more than 1350 yd^3 (1030 m^3).

SHOTCRETE SOLVES PROJECT CHALLENGES

The General Contractor was considering a difficult form-and-pour formwork process to try for the grade beams with very little access to each of the grade beam locations. As

Fig. 1: Grade beam with work platform

Fig. 2: Grade beam during shotcrete installation

Fig. 3: Finishes on grade beam

Fig. 4: Typical shear wall and boundary elements

the General Contractor started developing the project's detailed schedule, they realized that the formwork sequencing was not going to fit into the original timeline. The General Contractor contacted Dees-Hennessey Inc. (DHI) to help with the project's budget, construction limitations, and timeline issues. After some initial brainstorming, DHI selected shotcrete as the perfect concrete placement method. Some of the constraints the General Contractor faced that DHI took into consideration included the access limitation, formwork difficulty (how to brace the forms on a hillside when there is nothing to brace to), timeline to install the formwork, and getting the concrete to cure so that the tiebacks could be stressed and the next level could be started. Shotcrete was a solution to all of these issues.

THE PROJECT

The General Contractor's plan was to develop a work platform that could sit on top of a previously placed grade beam. Because the grade beams were uniform in distance, height, and setback, the deck could provide a work platform easily lifted to each level by sitting on the previous grade beam with little modification (Fig. 1). Once the platform was installed, the reinforcing bar cage could be set before shotcrete was placed on each of the grade beams. Shotcrete turned an almost impossible formwork situation into one not requiring any formwork at all.

Shotcrete placement also facilitated the ability to work around the anchor bolts while providing proper finishes for the tieback anchor plates (Fig. 2). The grade beam used a nozzle finish because it was going to be buried, and the design 28-day compressive strength of the grade beams was 5000 psi (35 MPa). However, to decrease the timeline for the stressing of the tiebacks, an accelerator was used to decrease the set time of the shotcrete, and a 6000 psi (41 MPa) compressive strength mixture was used to offset any potential strength loss due to the rapid set accelerator. The plan called for the grade beams to reach design strength and then stress the tiebacks 5 days after shotcrete placement. However, the shotcrete normally reached design strength in 3 days and the grade beams were typically turned over for stressing early (Fig. 3). The overall schedule originally planned for each grade beam to take 3 to 4 weeks per level to get access, formwork installed, poured, stripped, and stressed, but with the shotcrete process we were able to get a grade beam level every 1-1/2 weeks.

As the grade beam contract was wrapping up, DHI negotiated a change order for shotcrete placement of concrete for all of the vertical concrete walls on the project including shear walls, parapets walls, and retaining walls (Fig. 4). This provided schedule and economic benefits to the project, as well as the flexibility of shotcrete placement, as we could shotcrete some of the first structural walls the same day as the grade beams, and then some of the retaining walls at the end of the shift (Fig. 5). The characteristics of the shear walls, parapet walls, and retaining walls included shotcrete with up to 8000 psi (55.2 MPa) compressive strength, pumping distance up to 1000 ft (305 m), and a volume of over 3400 yd^3 (2600 m^3) with coverage areas of 90,000 ft^2 (8360 m^2).

Fig. 5: View of the jobsite with multi levels of grades beams and rear retaining wall to the project

2019 OUTSTANDING INFRASTRUCTURE PROJECT

Project Name
1395 22nd Street

Location
San Francisco, CA

Shotcrete Contractor
Dees-Hennessey Inc.*

Architect/Engineer
Perry Architects

Materials Supplier
Cemex

Equipment Manufacturer
REED Shotcrete Equipment*

General Contractor
Pacific Structures

Project Owner
RP Pennsylvania, LLC

*ASA Sustaining Corporate or Corporate Member

***Jason Myers** received his bachelor's degree in civil engineering from California Polytechnic University at San Luis Obispo, San Luis Obispo, CA, in 1995, and his MBA with an emphasis in project management from Golden Gate University, San Francisco, CA, in 2015. Myers began his professional career working for an earth retention subcontractor where he learned the importance of budgeting, scheduling, and client relationships. Also, during this time he was introduced to the use of shotcrete and its applications. After working for a general contractor for a couple of years he realized that he enjoyed the tighter knit of working for a subcontractor and the ability to construct projects on a tighter time frame with several going at once. Myers also enjoys the process of handling most of the procedures that go into constructing a project rather than seeing only a small portion of the process. He joined Dees-Hennessey Inc. in 2004 and has been a part owner of the company since 2007. Myers serves as the Vice President of Operations as well as the Safety Director. He is Chair of the ASA Membership Committee as well as a member of the ASA Board of Directors, Contractor Qualification, Education, and Safety Committees.*

2019 Outstanding International Project

The Pretoria Canopy

Transforming an "Ordinary" Edifice into an Architectural Landmark

By Eamonn Ryan and Dustin Strever

A 26 m (85 ft) long, highly unusual concrete portico over the entrance of a government building (The Pretoria Canopy), located in Silverton, Pretoria, South Africa, transforms a fairly ordinary looking building into an architectural milestone (Fig. 1).

Due to the organic nature of the structure, the architect proposed to use shotcrete early in the design process. Consultations with Shotcrete Africa SCP were held about 9 months prior to the start of construction.

The flowing, curved shape of the structure would probably have been nearly impossible with use of form-and-pour techniques. The one-sided formwork was a custom fabrication with over 300 individually laser-cut pieces creating a complex, undulating surface. To have to double the amount of formwork, precisely align the two sides, and brace for the incredible pressures that form-and-pour would have generated would most likely have necessitated a re-design of the structure to more easily accommodate the limitations and costs of standard formwork. Using shotcrete mitigated a lot of these problems and reduced the cost. Shotcrete thus enabled the architect to realize their one-off design in the shape and form as originally visualized (Fig. 2).

Sustainability advantages are typically recognized in varying degrees on all shotcrete projects when compared to form-and-pour concrete construction. Although this was a difficult and challenging shape to construct formwork for, the use of the shotcrete process achieved at least a 40% reduction in formwork, labor, and crane costs. This substantial reduction highlights shotcrete's natural sustainability benefits. The formwork took approximately 3 months

Fig. 1: View walking into the canopy

Fig. 2: View from inside the canopy

to erect from date of award to final use. Any extension in this time and the ensuing cost would probably have rendered the project unfeasible without a major redesign.

THE PROJECT

The R3-million Pretoria Canopy project entailed R1.6-million of formwork, just 70 m^3 (90 yd^3) of shotcrete, and a substantial 18 tonnes (20 tons) of reinforcing steel. The project was a tremendous learning curve for all and already interest has been generated in duplicating these skills and methods on other interesting projects.

Architect Pieter Breytenbach, Deter Architects & Designers, was given free imaginative reign on the concrete portico cover over the entrance. It was a fairly old building, so it was a challenge to design a structure which would complement the existing building while contributing something to its aesthetics. To achieve that, he employed one of the oldest and most robust structures ever designed—the arch.

Making it especially challenging was that the surrounding ground ramped up towards the entrance, so the design had to accommodate the gradient slope up to the building plinth. The only guidance from the client was that they wanted something "impressive."

The structure rises up towards the building entrance and narrows down to a diminishing point, indicating the way to the door almost like a target. That was the biggest challenge from a design point of view. Once the design was selected, the architect had to look at what could be taken away. One usually has heavy buttresses on an arch, but these were able to be done away with due to the capabilities of the concrete and the expertise of the engineers involved.

The idea was to open up the western side of the structure to provide sufficient natural light. It was fortunate that protection from the elements was afforded by the existing building. Polycarbonate (used as a roofing material because it doesn't transfer a lot of heat) was clad over ribs tucking into the structure on the sides which turned three-dimensionally.

As a result, when one approaches the building, the portico opens up in a well-lit manner, then closing in while tilting up slightly as the entrance is neared. Two large pillars and the gutters act as the keystone to the structure. There are long spans of unsupported, cantilevered concrete between the pillars, and that's a homage to the material worked with and what it is capable of.

SCOPE OF WORK

It is believed this is one of the only structures where every element of reinforcing bar has its own bar-mark—every single piece is individual, because everything is either diminishing or increasing in size and the whole structure is moving in three directions. It's definitely not like a normal column. The reinforcing steel design was done by the engineer, SCIP.

The concrete mixture design included admixtures such as Penetron, silica fume, and high-range water-reducing agents to achieve a slump of just 80 mm (3.2 in.). The columns are 800 mm (32 in.) deep and 2.4 m (8 ft) wide.

Peri was responsible for the design of the formwork and shoring. All formwork elements for the soffits were prefabricated by Peri off site to be delivered for assembly on site. The structure is asymmetric in section and formwork design had to be done in three-dimension (3-D), taking existing structures into account. From a formwork point of view, this project was highly unusual, and many contractors made the decision to not get involved.

Construction started with the installation of a designed network of props and scaffolding to support the ribs of the canopy. Each individual rib was laser-cut and no two were the same. The forming ply was then placed and fastened to the support structure. At all times, strict health and safety was maintained. An initial layer of shotcrete was then placed to avoid using "spacers" that would have negatively impacted the smooth finish required by the architect. This, however, did not go 100% to plan.

The design and installation of the reinforcing bars was also a challenge. A hands-on approach was the only way to get the job done (Fig. 3). This project was a question of complete commitment from all involved and required clear vision in terms of what had to be achieved. The progress meetings required detailed technical discussions and the various trades worked much closer together than normal. The reinforcing steel bending schedule was complex and required many clarification meetings to ensure it was designed and installed correctly.


Fig. 3: Complex reinforcing steel for the canopy

Fig. 4: Shooting the canopy

Shooting this intricate web of steel was easy enough (Fig. 4); however, work had to stop occasionally to "catch up" with rebound removal. At all times, an airlance was used to prevent encasement of rebound in the finished sections. We did struggle with "finishing" the placed shotcrete in time before it hardened, but any unfinished work was cut down to 30 to 50 mm (1.2 to 2 in.) below the final surface whilst still wet. This allowed slower placement and careful attention to finishing the following day. A saturated surface-dry (SSD) condition was achieved before applying the final finish coat and hessian burlap and a mist system was used overnight to ensure good curing.

Fig. 5: A view of the curved column with canopy sitting on the form

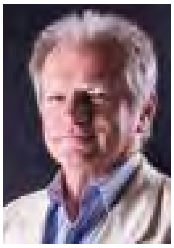
The mixture design was critical to achieve an ideal slump that enabled the company to shoot the 800 mm thick columns through two layers of heavy reinforcing bars with a minimum of rebound and excellent encapsulation of the bars (Fig. 5). The addition of Penetron to the mixture reduced the concrete permeability and helped ensure a long-lasting, durable concrete structure.

On completion, the structure was allowed 14 days to achieve 80% of design strength and then the formwork was removed in stages. It was a tense moment when the final formwork was lowered. The structure sagged less than 10 mm (0.4 in.) at the furthest point and a collective sigh of relief was no doubt shared by all involved. The top of the structure was then inspected for any movement cracks and as a precaution some micro cracking (found to be less than 1 mm thick and 15 mm deep) was repaired using dry-mix shotcrete. A week after completion the repaired section exhibited no further visible cracking.

Conclusions

Shotcretes uses and benefits continue to allow far sighted architects, engineers, and contractors to push the boundaries of what is sometimes thought of as impossible to achieve. This project exemplifies shotcrete's creative ability to transform the architect's vision into a solid and durable concrete structure (Fig. 6).

Fig. 6: A side view of the finished structure before painting



Eamonn Ryan *is a Journalist and Editor with more than 20 years of experience contributing to almost all South Africa's financial newspapers and magazines, as well as several overseas publications. He previously served as the Business Editor of* Finweek *and as Editor of various technical magazines, including* Civil Engineering Contractors *(a 50-year-old magazine) and* Quarry SA. *He currently serves as Editor of* Plumbing Africa *and* SA Affordable Housing.

Dustin Strever *is the Founder and Managing Director of Shotcrete Africa SCP—Africa's largest specialist shotcrete contractor. Based in Johannesburg, South Africa, Shotcrete Africa SCP offers a variety of shotcrete application services, ranging from small concrete repair using the dry-mix process to bulk structural using the wet-mix shotcrete application. Together with his wife Lynne, Business Manager, they employ over 75 staff. Strever has been involved in the shotcrete industry for over 15 years and was first exposed to dry-mix shotcrete when a client asked him to spray a 7 km (4 mile) precast concrete wall to add robustness. Since then, Strever has made it his mission to improve the perception and quality of shotcrete in South Africa, educating himself and staff with the assistance of the American Shotcrete Association and other leaders in the field. Shotcrete Africa SCP has been a corporate member of ASA since its inception.*

2019 OUTSTANDING INTERNATIONAL PROJECT

Project Name
Pretoria Entrance Canopy

Location
Pretoria, Gauteng, South Africa

Shotcrete Contractor
Shotcrete Africa SCP*

Architect/Engineer
Pieter Breytenbach - DETER Architects

Materials Supplier
Metier Mixed Concrete

Equipment Manufacturer
REED Shotcrete Equipment*

General Contractor
Bhekinani Civils & Projects

Engineers
SCIP

Formwork Design and Shuttering
Peri

Steel Supplier
Piovesan

*Corporate Member of the American Shotcrete Association

Purlear Creek

By Ryan Oakes and Anna Ploghoft

In North Carolina, we are quite fond of our local swimming holes. Ask any Tar Heel, and they will assuredly regale you with tales of their childhood spent swinging wildly from ropes and jumping from or sliding down boulders. The swimming hole always held magic for us when we were small, with water that glowed with microscopic fool's gold, and tiny fish that would nibble at our feet. It was a place where we could run, jump, and splash, all while nature was busily oiling the wheels of our young imaginations. It's a scene that one North Carolinian couple wished to recreate for their grandchildren, right in their backyard.

THE INTERVIEW

We were contacted by a prospective client in early 2017 who wanted to build a swimming pool on the hill behind their house. They knew they wanted a pool, but also knew that with the natural beauty of the property they had purchased, the last thing they wanted was to construct something that stood out as built. The center of the project quickly revealed itself as the hill. The client's grandchildren had made a tradition of using makeshift sleds to slide down the leaf-strewn hillside adjacent to their cabin during the fall months, and the client made a point of wanting to preserve the spirit of this activity in the new design. They had also expressed their enjoyment of hiking down the hill to a waterfall, though the hike itself is pretty grueling. No less important to the project was a need to provide a place for activity through multiple seasons. It is the Blue Ridge Mountains, after all, and the summer season is short relative to the rest of the state.

DESIGN

We started, as always, with an idea of how the project should be used, then drafted a hand sketch. We presented to the client a concept of a multi-tiered creek and a hillside boulder garden for spring, summer, and fall fun. In-between two tiers of the pool would sit a large rock from which to slide and jump, therein preserving the spirit of the downhill leaf-sledding tradition. The "boulders" would be carved with the help of experienced rock climbers and artists, creating the opportunity for the children to test their strengths year-round. Our client was thrilled and immediately wished to move forward with the project.

Once the hand sketch was done and the concept was established, we immediately went to work doing a three-dimensional (3-D) scan of the property and drafting 3-D models of all the boulders and watershapes, the spa, the creek, and the pool. Simultaneously, we visited various local waterfalls, creeks, rivers, and boulder outcroppings for ideas and inspiration to draw upon.

Once a model was settled upon, we were able to go to engineering and determine the quantity of reinforcing steel, concrete, and other materials for the project. As well, we immediately began determining how we would service such a project.

LOGISTICS

Even though we use the dry-mix shotcrete process, when working out of town or anywhere that we don't have our own satellite batch plant, we coordinate with local ready mixed plants to get raw concrete materials. Here, however, we were on top of a single mountain, an hour away from the nearest possible reload point, and we had a few other variables that led us to the solution of setting up a temporary batching site. One of these variables was the sheer size of the job—this project used nearly 3,000,000 lb (1,360,000 kg) of concrete! Daily construction progress over the course of 18 months would also prove hard to predict.

Fig. 1: Local aggregate staging area for volumetric batch trucks

Though the project spanned over 18 months, the actual shotcrete components happened intermittently over 9 months and ranged from a day to a few weeks at a time. Thankfully, the neighborhood is still under construction and the developers allowed us to use an empty construction lot to stage hundreds of tons of aggregate, a portable silo, a water tanker, and a loader so that we could batch our trucks less than a mile from the jobsite (Fig. 1). This allowed us to minimize trucks needed to service the job. We kept no more than two volumetric batch trucks at any given point during the pool construction and only one batch truck during the rockwork component. One compressor and one rotary barrel dry-mix gun were on site at all times. We also kept a rotary bowl dry-mix gun on site for backup.

We shot the main pool first and worked our way back up the hill for the creek and spa, but then went back down months later to begin the rock work.

Once we resolved the construction access challenges, such as this being a very steep hill, with the lowest work being over 130 ft (40 m) below the truck and gun locations, and over 300 ft (90 m) away from the truck, we began to work on concrete mixture designs to achieve the performance qualities we wanted.

Mixture Design

Rock carving is a slow process, involving a great deal of starting and stopping over the course of a day. The dry-mix shotcrete process was an essential method providing us the flexibility to shoot long distances, in extremely awkward places, and start and stop at leisure. We would sometimes only shoot one truck of material over the course of a 12-hour day.

Typically, on larger, more production-oriented projects, the level of detail is lower than that of smaller-scale residential projects where a client is viewing the work more closely. But being a large-scale residential project with the need for a high level of detail, we needed to be able to carve for an extended duration of time. To achieve a slow set time and not hinder long-term strength gain, we used a blend of 30% slag cement and 70% portland cement. The slag cement slows heat of hydration and provides us plenty of time to carve yet still stack the material. We could carve for hours after placement and even make changes and details the day after placement. The slag cement also helps to decrease permeability, which is ideal on a project that is in large part underwater or has water flowing over it. Cores from test panels that were shot without other supplemental cementitious materials (SCMs) would show the slag blends to produce long-term break strengths over 11,000 psi (76 MPa) as well. Being able to incorporate a product as sustainable as slag cement, a by-product of the steel industry, into such a large-scale project was a real plus.

To reduce rebound and increase density even further, we replaced 5% of the portland cement with silica fume. This helped significantly reduce rebound, which helped counteract the slight increase due to the slag blend. The silica fume also helped us to stack material more thickly for interesting rock features and further decrease the concrete's permeability. The addition of jute and hemp fibers further aided stackability, though the primary reason for this addition was to help reduce shrinkage cracking. We used 2.2 lb/yd^3 (1.3 kg/m^3) of natural fibers.

Though we had a great reinforcing steel schedule for our structural shotcrete thickness, our carve coat didn't have any reinforcing steel. The thickness of the carve coat can range from 1 to 9 in. (25 to 225 mm) in thickness. In over 9000 ft^2 (840 m^2) of rock carving, we experienced almost no visible plastic shrinkage cracking and practically no efflorescence. We attribute this to the use of our mixture design as well as using best practices for application, including good nozzle technique with ACI-certified shotcrete nozzlemen along with fervent use of the air lance, in some cases even using two air lances to keep rebound and overspray clear of connection points from previous work.

Man-made rock work, commonly referred to as "artificial rock," "fake rock," "zoo rock," or "Disney rock," is often rife with efflorescence and shrinkage, especially when it is carved by hand as opposed to using GFRC panels and mending them together. We were excited to see such minimal shrinkage cracking in our project after completion.

From Concept to Completion

Creating man-made rock is an exceptional concept from start to finish. The details we see as a finished product are typically visualized long before the coloring of the project. In fact, they are almost entirely set in motion from the steelwork or formwork, which relies completely on good design.

The academic version of the process goes like this:

1. Inspiration
2. Vision
3. Rendering/modeling
4. Formwork
5. Reinforcing steel (though some skip this step)
6. Structural section to embed the reinforcing steel and initiate form
7. Carve coat or stamping for form and detail
8. Coloring or staining and other "tricks of the trade"

For us, the inspiration started over 25 years ago when I began climbing. I became immersed in the Appalachian bouldering and climbing scene and met some of the most influential climbers of the day. Two of those individuals would come to find a place on this project, Joey Hinson and Peter Glenn Oakley. Coming back to university after a hiatus, the discovery of rock climbing helped define my character. It created a mind-body connection that I had not acknowledged before, along with deep friendships and understanding of physics that only climbing can extort. I went on to climb around the world, including some great heights like El Capitan in Yosemite Valley, but bouldering in the Appalachians is the distilled version of all forms of climbing. And so, when this project came along, it was natural that those boulders, indelibly ingrained in my mind, would find their way to paper. Hinson is still an active boulderer of international fame, and makes a living in part, drawing boulder fields that he had a part in discovering and developing. So, when I had this idea, I enlisted him to take my hand draft and make it more artful with his style. The client loved it. Unfortunately, building an entire boulder field, with a vanishing edge spa, a creek, and a vanishing edge pool on the side of a mountain accurately, can't really be done from a hand drawing. From there we went through 14 iterations of CAD models in a building information modeling (BIM) software called Revit. This provided us the ability to narrow down the accuracy and placement of the entire structure as well as track its construction progress through surveying during the 18 months it took to build.

One of the key components to designing with BIM was that we could take research gleaned from local rivers and sliding rocks (Fig. 2) we knew and apply it to our computer model. We knew it was easy and fun to slide down Turtle-back Falls and Sliding Rock in Pisgah, NC, so we studied the angle of those renowned locations. Then we looked at the friction point of polished wet concrete and the maximum static friction value of an adult versus a child to determine what angle would work for our project and how much we would need to polish the surface after placement of the concrete where the slide in the boulder would provide a safe but fun speed.

Though this entire project was modeled in Revit and daily survey points were established and lost and re-established through full-time surveying by our superintendent, this was still an art project, and it proved to be very dynamic in this regard. Bending reinforcing bars in forms other than 90 degrees and with completely random placement requires a sense of the finished project, so we not only used our staff, but we hired local climbers and recruited the help of our friends at Artisan Skate Parks. Having workers who tie reinforcing steel in compound curves on a daily basis was immensely helpful, and having folks who climb and have an intimate knowledge of natural boulder formations was indispensable. To get our pool building staff, the skaters, and the climbers all on the same page, I used modeling clay, along with the help of Hinson, to create an image of the project to guide everyone to a similar vision, beyond all of the 3-D rendering and video imagery (Fig. 3).

Raising the Bar

Before embarking on this project, I must mention that though we had experience in carving rock and the clients had seen our previous work and loved it, we wanted to raise the bar. We felt that a project like this, being in the mountains, so close to my old stomping grounds, with the pool and the vista beyond, deserved to exceed the clients' expectations. A friend of ours turned us on to Ocean Rock Industries, out of British Columbia (BC), as real heroes in the man-made rock world, so I reached out to the Owner, Dan Pitts. He embraced the idea and we arranged a consulting relationship for this project, where he would teach us some "tricks" and coach us through improving our game, from the structural sections to the carve coat and especially the coloring. Pitts, having mentored under a world-famous carver himself, had much to share. And, when it came time to shoot, Pitts came to North Carolina to supervise the work which he had coached us in. The very first thing we did was to take him to a private boulder field near Hinson's home and show him around. We had him climbing and feeling out our rock, which differs so greatly in every aspect from the Western BC rock that he is familiar with. This intimacy would prove to be invaluable in our carving because we needed to align his vision with


Fig. 2: Researching the North Carolina rock


Fig. 3: Clay model of the project

ours. We also visited the boulders and waterfalls further down the property, which helped inspire the project from the beginning.

Our carve team included me (Ryan Oakes), Oakley (friend and climbing companion of 25+ years and famous marble sculptor), and Hinson (geologist, artist, and world-famous boulderer), all under the very careful eye of Pitts. We had others helping as well; the list is long, and the support team was invaluable in this process. From rebound removal to air lance operating to reinforcing steel adjustments and the ongoing dynamic of carving rock, the process was labor-intensive.

Shooting these features turned out to be a little trickier than we had initially conceived. However, thanks to having a bunch of climbers around, we made quick work of some of the more logistically challenging aspects and even found ourselves putting nozzlemen on rappel (Fig. 4) or being harnessed and tied off by rope while hanging over the edge of a previously shot boulder. We maintained a steel safety line to connect climbing leads and belay devices through the duration of the project. These would stay in place all the way through to coloring before finally cutting safety anchors out and patching the holes so that the coloring effects would hide any evidence of their existence.

In safer but more physically difficult placement situations, our nozzlemen found themselves laying on their backs, shooting upside down directly overhead just a few feet away. This makes for a bit of messy work but thinking of any other way to achieve the finish qualities is unreasonable, to say the least. The shotcrete process is the only practical way to make this high-quality, durable concrete placement happen.

Fig. 4: Nozzleman shooting the steep rock face while being suspended on belay

The flexibility of the shotcrete process allows the artists themselves to grab the hose and nozzle the material to a much closer specification than trying to translate to a nozzleman who may not share their own particular vision for the finished product. The artists would, of course, be under close supervision by a trained nozzleman, but again, this flexibility is one of the true beauties of the shotcrete process.

Conclusions

Over 9000 ft^2 of artisan-carved rock were installed in and around a water feature of 70,000 gal. (265,000 L), including a 12 ft (3.7 m) deep vanishing edge pool with a 14 ft (4.3 m) high jumping rock (Fig. 5).

The pools all have concrete compressive values ranging from 5000 to 7500 psi (34 to 52 MPa) while the rock work has compressive values ranging from 6500 to 11,440 psi (45 to 79 MPa) and higher.

Fig. 5: Overview of the project near completion

Over 700 yd^3 (540 m^3) of concrete, weighing nearly 3,000,000 lb, were placed using the dry-mix shotcrete process (Fig. 6).

Specialized mixture designs allowed us to place concrete and carve for hours without initial set interference. Even next day manipulation was possible to some degree.

Fig. 6: Bird-eye view of the finished project

2019 OUTSTANDING POOL & RECREATIONAL PROJECT

Project Name
Purlear Creek

Location
Purlear, NC

Shotcrete Contractor
Revolution Gunite*

Architect/Engineer
Clearwater Construction Group and Watershape Consulting

Materials Supplier
LafargeHolcim and Natural Reinforce Fibers & Co.

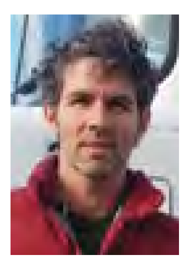
Equipment Manufacturer
Gunite Supply & Equipment* and King*

General Contractor
Clearwater Construction Group, Inc.

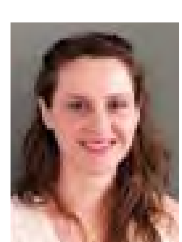
*ASA Sustaining Corporate or Corporate Member

Practically no formwork was used for the rock work and minimal formwork was needed for the pools. Altogether, this was a project that took our vision of what could be achieved and through research, modeling, and hard work turned that vision into a high-strength, durable concrete "swimming hole" that looked right at home in the North Carolina mountains (Fig. 7).

Fig. 7: The brand new "ole swimming hole"



Ryan Oakes *is a Professional Watershape Designer and President of Clearwater Construction Group, Inc., Revolution Gunite, and Revolution Pool Finishes, all of which are award-winning firms in their respective trade. Oakes is a faculty member at Watershape University, where he continually aims to raise the bar in the swimming pool and the watershape construction industry. As a member of the leadership team for the International Watershape Institute (IWI) and through educational outreach to a vast pool builder network throughout the United States, he aims to improve the building techniques and methods of constructing swimming pools. Oakes is a member of ACI Committee 506, Shotcreting, and ACI Subcommittee 506-H, Shotcreting Pools. He serves on the ASA Board of Directors and also serves as Vice Chair of both the ASA Pool & Recreational Shotcrete Committee and the ASA Contractor Qualification Committee.*



Anna Ploghoft *received her BA in biology from the University of North Carolina at Greensboro, before studying architectural engineering technologies at Norwalk College, Norwalk, CT, in 2014. Specializing in fluid engineering, BIM design, and CAD design, she has been designing for Clearwater Construction Group since 2017.*

2019 Outstanding Repair & Rehabilitation Project

Falls Village Penstock #1 Structural Shotcrete Rehabilitation Project

By Billy Roy and Andrew Lawson

In early November of 2018, Knowles Industrial Services Corporation (KISC) was issued a contract by First Light Power Resources, Inc. (FLP) to perform a structural shotcrete liner within a steel-riveted penstock at the Falls Village Hydro Electric Plant in Canaan, CT. FLP's request for bids permitted contractors to provide a design-build approach for a structurally self-sustaining system to be built within the penstock interior. The existing 9 ft (2.7 m) diameter, 360 ft (110 m) long penstock was buried in its entire length on a steep bank and crossed underneath a live highway. Penstock replacement by excavation proved to be too costly, as much of the existing penstock beneath the roadway was encased in reinforced concrete requiring significant demolition and interruption to traffic in this area.

BID REVIEW PROCESS

During the bid review process, three different repair methods were presented, which included hand-laid fiberglass mat systems, structural epoxy liners, and structural shotcrete. KISC provided a unique, low-cost reinforced shotcrete approach. It was imperative that the awarded contractor provide structural calculations demonstrating that their method would be self-sustaining and could withstand all static and water hammer pressures while in operation, 13.1 lb/in.^{2} (0.09 MPa) and 2.2 lb/in.^{2} (0.015 MPa), respectively. Calculations were not to consider any strength contribution from the existing riveted steel shell, whose structural integrity was questionable and impossible to conservatively define. With two professional engineers on staff specializing in penstock shotcrete and steel reinforcement design, KISC was able to secure the contract by providing a series of structural calculations and submittals that met the strength requirements for the new penstock when operating at full capacity.

THE DESIGN

KISC worked with Kleinschmidt Associates, Inc., the Engineer-of-Record, to design a shotcrete liner that met the structural demands of the environment without significantly reducing the existing pipe's cross-sectional area, which would ultimately affect the overall power generation potential of the turbine units at the power station. In addition, a decrease in Manning's coefficient was desired to promote increased laminar flow. It was determined the Manning's coefficient for riveted steel is (0.19). KISC provided FLP and Kleinschmidt with substantial data proving that the new Manning's coefficient for smooth concrete would be (0.012) and the eventual epoxy coating would further decrease the Manning's coefficient to (0.010), ultimately providing less friction losses and higher water velocity to combat any losses due to reduced cross-sectional area.

Each structural shotcrete penstock liner is unique. The design process is complex and requires attention to various details and site conditions. External forces, such as soil overburden loads, bending and shear stresses, and highway loads, must be considered in the design process as well as internal hoop stresses, such as static and water hammer pressures and flow geometry.

This particular penstock design and construction was the tenth of its kind for KISC over the past 10 years. Over the years, KISC has worked with several engineering firms throughout New England to design and build reinforced penstock liners that have been approved and often favored by the Federal Energy Regulation Commission (FERC). KISC has assisted various owners and engineers on several penstock projects by compiling data and submitting packages for the shotcrete process which has, over time, become one of the preferred repair methods for water-filled pipes.

The original bid documents indicated that FLP would supply the awarded Contractor with a 6-week canal outage to perform the work. The approximately 2000 ft (610 m) canal diverts water from the Hoosatonic River which supplies three 9 ft diameter penstocks to the 9 MW power station. Penstock #1 was one of three penstocks that would be entirely de-watered during this station outage. KISC indicated the project duration would require a 12- to 13-week effort from start to finish. This condition was unacceptable to the FLP at that time, as the cost of leaving the canal dry and keeping the entire station (all three penstocks) offline for more than 6 weeks was not feasible for the owner due to the lost revenue from potential power generation. Furthermore, FLP's Safety Department was concerned with work being performed downstream of the existing Penstock #1 head gate if the canal was left at full capacity. KISC was charged with developing a work plan and method that could allow for the shotcrete work to be completed over a 12- to 13-week schedule without sacrificing lost power generation in Penstock Units #2 and #3.

The KISC Engineering team, comprised of Senior Vice President Andrew Lawson and Project Manager Billy Roy, began to value engineer an approach that would provide the necessary schedule time while not sacrificing FLP revenue. KISC committed to designing a temporary, secondary safety bulkhead upstream of the Penstock #1 head gate. The 1-1/4 in. (32 mm) thick steel safety gate would provide a secondary level of protection in the event that the existing penstock intake gate failed under the hydrostatic pressure of a full canal during construction. This approach would permit safe working access into Penstock #1 for KISC workers for 13 weeks without requiring a total station outage. This permitted FLP to continue generating power in Units #2 and #3 without interruption during the construction in Penstock #1. Additionally, this process allowed for the flexibility to work in winter months during historically lower river flows when water availability is not abundant enough to sustain continuous operation of all three units. This value-engineered approach resulted in KISC being awarded the contract for Penstock #1 at the originally requested 13-week schedule.

As part of the contract specifications, KISC was tasked with providing design calculations for the shotcrete reinforcing steel required to withstand the static and hammer water pressures in this penstock. The KISC Project Manager, Billy Roy, determined that the reinforcing bar configuration would be #4 (#13M) longitudinals spaced at 12 in. (300 mm) radially and #5 (#16M) prebent radial hoops spaced at 6 in. (150 mm) longitudinally. The reinforcing bar mat would be tied to a series of 1.5 in. (38 mm) slab bolsters welded longitudinally down the length of the penstock and spaced at 4 ft (1.2 m) radially. As with all water delivery pipes for power generation, it is imperative to design a shotcrete product that provides sufficient cover over the embedded steel while maintaining a small loss in overall cross-sectional area of the pipe. KISC elected to use Quikrete Shotcrete MS at 4 in. thickness around the circumference of the pipe. Rebound removal was difficult on this site due to limited access in and out of the work area, so a higher concentration of silica fume was desirable to minimize rebound and unnecessary cleanup labor.

Construction

KISC mobilized to the site on October 15, 2018. Construction began by excavating two areas through the soil overburden to expose the tops of the existing penstock to provide various points of worker access as well as to provide means of expelling shotcrete dust. Two large holes were cut in the existing penstock steel.

Fig. 1: Temporary safety bulkhead

Fig. 2: Excavated manhole access

Once the pipe was entered, the entire substrate was pressure washed with 5000 lb/in.^{2} (34 MPa) water blasting. All areas to receive 1.5 in. welded slab bolster were ground for cleanliness and to promote weld strengths. The project consisted of welding 2100 ft (640 m) of 1.5 in. continuous slab bolsters, installing 6.5 miles (10.5 km) of reinforcing steel, and applying 150 yd^3 (115 m^3) of Quikrete Shotcrete MS. Smoothness of the finished shotcrete was incredibly important on this project. As with all hydroelectric utilities, great care is taken to prevent any power generation reduction due to friction losses anywhere within the system. To maintain Manning's coefficient of (.012) for smooth concrete, cutting and finishing was a labor-intensive and necessary process. This would ultimately lead to increased laminar flow, higher water velocity, and subsequently higher generation capacity. KISC crew members spent considerable time finishing the entire 10,200 ft^2 (950 m^2) interior of Penstock #1.

Fig. 3: Welding steel transitions at upstream and downstream shotcrete terminations

Fig. 4: Reinforcing bar installed

Shotcrete Inspection

Specifications required the involvement of a third-party shotcrete consulting firm to provide unbiased commentary and inspection of the shotcrete process. Ray Schallom of RCS Consulting & Construction Co. Inc. was contracted to provide insight, education, and inspection services to assure that all shotcrete work and techniques were aligned with the project specifications. Among the topics inspected by Schallom were reinforcing bar layout and cover, silica awareness and mitigation, shotcrete finishing, and curing procedures. Final reports submitted by RCS Consulting reported no deficiencies in the shotcrete process implemented by KISC.

Project Challenges

Some of the challenges faced on this project included confined space entry and rescue, winter conditions with cold temperatures, shotcrete curing, and transporting large quantities of construction materials at great distances by foot. KISC provided all confined space permitting, air monitoring, attendants, and rescue services. To combat winter temperatures, all gunning and pre-dampening operations were confined to heated enclosures built near the work area. KISC crews exercised great diligence in protecting air-powered equipment from frequent freezing and provided ample protection for shotcrete materials stored outdoors at the site.

Conclusions

The project was completed on time in the original 13-week schedule. KISC crews worked 50 hours/week, including several weekends on and around holidays. The temporary safety gate was removed on January 4, 2019, and the penstock was placed back into operation later that afternoon with no startup issues. The owner expressed gratitude for the timely, cost-effective approach engineered by KISC which created very little power generation losses throughout the duration of the project.

In July 2019, KISC crews returned to Falls Village Hydro during the annual outage. The shotcrete liner was inspected after operating for approximately 7 months. No defects were found. FLP was pleased to announce that after collecting power generation data over that time period, no generation losses were reported due to the installation of the shotcrete liner. KISC finished the project by abrasive brush blasting of the entire 10,200 ft^2 penstock shotcrete liner and applying two 30 mil (0.76 mm) spray coats of high-build epoxy. The intent of the epoxy was twofold; to extend the service life for the shotcrete and to provide a lower Manning's coefficient to promote more laminar flow. The epoxy lining project was completed in the scheduled 2-week timeframe.

Fig. 5: Falls Village Penstock shotcrete

***Billy Roy** is a Project Manager for Knowles Industrial Services Corporation based in Gorham, ME. He received his BS in construction engineering technology at the University of Maine College Of Engineering in 2013, and became licensed as a Professional Engineer in Maine in 2018. Roy specializes in design and management for various shotcrete, concrete repair, and grouting projects throughout New England. He is an ACI Certified Concrete Testing Technician, a NACE CIP Level 2 Inspector, and holds a Lead Abatement Supervisor certification with the State of Maine.*

***Andrew Lawson** is Senior Vice President for Knowles Industrial Services Corporation based in Gorham, ME. He is a Professional Engineer in Virginia. He received his BS in civil engineering from Virginia Tech, Blacksburg, VA, in 1976. His 38-year on-going career with KISC began in 1982. He continues to serve the functions of Estimator and Project Manager specializing in shotcrete, concrete repair, and grouting services throughout the New England states, particularly with hydro-electric/water structures. He is certified in Maine as both an Environmental Design professional and Lead Abatement Supervisor and holds a NACE CIP Level 1 designation.*

2019 OUTSTANDING REPAIR & REHABILITATION PROJECT

Project Name
Falls Village Penstock #1 Structural Shotcrete Rehabilitation Project

Location
Falls Village, CT

Shotcrete Contractor
Knowles Industrial Services Corporation*

Architect/Engineer
Kleinschmidt Associates, Inc.

Materials Supplier
The Quikrete Companies*

Equipment Manufacturer
Allentown

General Contractor
Knowles Industrial Services Corporation*

Project Owner
First Light Power Resources, Inc.

*ASA Sustaining Corporate or Corporate Member

2019 Outstanding Underground Project

Maryland Purple Line Plymouth Tunnel

By Nick Tabor and Norbert Fuegenschuh

The Plymouth Tunnel is a 1020 ft (311 m) sequential excavation method (SEM) tunnel located in Silver Spring, MD, that makes up a portion of the Maryland Transit Authority's (MTA) Purple Line light rail connecting the existing metro lines around Washington, DC. The Purple Line Transit Constructors (Flour/Lane/Traylor Joint Venture—PLTC) is the Lead Contractor with the Traylor personnel self-performing the excavation and lining work for the Plymouth Tunnel.

The Plymouth Tunnel was constructed using the SEM with shotcrete comprising both the initial and final support. The initial excavation was a 27 ft 4 in. (8.33 m) tall by 35 ft (10.7 m) wide horseshoe phased into a 20 ft (6.1 m) top heading and 7 ft 4 in. (2.23 m) bench. Most of the alignment runs under neighborhood streets with cover varying from 15 to 40 ft (4.6 to 12.2 m) above the crown. As both shotcrete applications are being included in the final design as a composite structure, the initial support shotcrete had to meet the 75-year design life criteria for permanent concrete. In addition to the early-strength requirements (1, 3, 6, and 12 hours), the ultimate 28-day strengths now had to be considered and the water-cementitious materials ratio (*w/cm*) had to be limited to less than 0.42. These requirements left little room for improving as the project progressed and required a quality application from the beginning.

EQUIPMENT SELECTION

To handle the 24-hour work cycle and the strict quality control requirements, a robotically applied wet-mix process was chosen. An ACT WiCoMix WM 1500 planetary mixer batch plant with a mixer capacity of 1.25 yd^3 (1 m^3) was installed on site and operated 24 hours a day for 1-1/2 years in all weather conditions. The batch plant was enclosed within a steel metal building with multiple heaters at critical points and heated wraps on the admixtures. A boiler and chiller were used in the winter and summer, respectively, and occasionally ice was required during the summer. The aggregate stockpiles were covered and had radiant heaters during winter and misters during summer.

Shotcrete was transported to the heading with three 7 yd^3 (5.5 m^3) Fiori DB 560 Ts with modifications to bring them into National Ready Mixed Concrete Association (NRMCA) compliance. The trucks were kept within the shade of the plant when possible and pretreated with boiling or chilled water as needed prior to batching. Shotcrete was primarily applied with two Meyco Potenza shotcrete robots, but a Meyco Oruga and hand application setup were also on site in case of an emergency. This equipment setup was used for the top and bottom heading during initial excavation as well as the shotcrete final liner.

Fig. 1: ACT WiCoMix WM 1500 Batch Plant with buildings and silos

Fig. 2: Plymouth Tunnel East Portal top heading excavation

SEM/NATM EXCAVATION

For the initial excavation of the Plymouth Tunnel, top heading rounds were taken in 4 to 5 ft (1.2 to 1.5 m) lengths. Support was comprised of a 2 in. (50 mm) flash coat followed by 13 in. (330 mm) of shotcrete with two layers of wire mesh. The shotcrete section was installed in two lifts to minimize sloughing and to eliminate the need to shoot through a second layer of reinforcing mesh. Due to safety requirements, no personnel access was permitted under freshly applied shotcrete until it was self-supporting (75 psi [0.5 MPa]). To minimize downtime due to this curing period after the first lift, the second layer mesh and shotcrete application was delayed until subsequent rounds or when multiple rounds could be shot at once. Based on the ground conditions, it was acceptable to delay the second 6 in. (150 mm) application to anytime within three rounds of the excavated face. The second layer of mesh installation could then occur during other work activities and was often concurrent with the drilling for the spiling.

A wire mesh reinforced shotcrete design was chosen for multiple reasons. One of the biggest reasons was the wire mesh served as a continuous grade indicator and served as a visual cue for the nozzlemen. Repeatedly having a flat reference ensured high points were not projected through the subsequent lifts and helped minimize any dips between the lattice girders. Providing this reference plane also served as the quality control check needed to ensure minimum thickness was applied. In addition, it eliminated the flexural strength testing which would have been required for fiber-reinforced shotcrete. As a bonus, removing the fibers from the mixture design minimized the material costs lost in the rebound and from the filling of over excavated areas. While there was still a waste factor with the mesh installation, it was trackable as a separate entity and easier to minimize than shotcrete rebound. Additional labor costs associated with the mesh installation were found to be minimal as the activity could be concurrent with other critical path activities most of the time.

Geology along the alignment varied from highly weathered saprolite and raveling sands to full-face bedrock with rock mass conditions. Due to the wide-ranging stability characteristics, the ground support sequence was determined daily based on the ground conditions. For the more stable face conditions, a 2 in. thick flash coat on the open ground was sufficient protection prior to the first wire mesh installation. In unstable geology, a center buttress (face wedge) was used and occasionally pocket excavation was needed. In these situations, the face was divided into thirds around the center buttress and each was exposed and supported with shotcrete sequentially. This limited the open time and prevented the looser material from raveling due to air slack. The quick shotcrete application lead to minimal settlements of the surface streets averaging less than 3/4 in. (19 mm) with no noticeable settlement to the surrounding structures. In total, over 5600 yd^3 (4281 m^3) were applied during the top heading excavation and 1000 yd^3 (765 m^3) in the bench.

During the installation, the excavation and shotcrete profiles were scanned with a survey suite provided by Amberg Systems. This consisted of the Amberg Tunnel software with a Leica TS-16 and Faro Focus 3D scanner. The software allowed for the comparison between the theoretical profiles, as-built excavation, and shotcrete lifts. These profiles captured and quantified the excavation over-break and actual applied shotcrete thickness. This helped the nozzlemen to maintain a final shotcrete smoothness within +/- 1 in. (25 mm)along the tunnel. With the thickness as-built records and tight smoothness criteria, PLTC was able to take

Fig. 3: Top heading flash coat application in mixed face conditions

Fig. 4: Completion of initial lining after excavation

advantage of the overbreak volume and eliminated an additional 2 in. shotcrete regulating layer from the initial lining. This minimized the waste normally lost to the overbreak, saved the cost and time for the additional 2 in. application, and provided greater tolerance for the final installation.

Beton- und Monierbau USA, Inc. (BeMo) was a key partner to the successful completion of the tunnel. BeMo provided key foremen that not only served as experienced eyes in the field but also as shotcrete trainers and nozzlemen. The key foremen worked with the crews to provide operational experience during excavation works, ground support measure installation, and shotcrete application. They were on site for the entire installation and assisted with all critical operations.

Shotcrete on PVC Mockup

After completion of a form-and-pour invert (17 sections with single lengths of 60 to 70 ft [18 to 21 m]), the design called for a polyvinyl chloride (PVC) waterproofing membrane followed by an additional 13 in. of structural concrete with two layers of wire mesh reinforcement and at least 2 in. of polyfiber-reinforced concrete on the intrados. Due to the short tunnel length and multiple geometry changes for service utilities and permanent ventilation fans, the upfront cost of the form-and-pour formwork was prohibitive. The shotcrete equipment was already on site and the team had already demonstrated their ability to control the profile to meet the stringent final lining criteria. A proof-of-concept mockup was constructed within the tunnel to demonstrate the feasibility as well as to test various methods for supporting the PVC membrane. The PVC membrane was installed from the springline past the overhead arch along 15 ft (4.6 m) of tunnel within an area of over excavation. The proposed supporting measures and mesh were installed per the tunnel design and 6 in. of shotcrete was applied. Cores were taken through the different sections and the gap was measured between the PVC membrane and the two shotcrete layers. These gaps resulted from the “pillowing” inherent with the PVC installation but could be drastically reduced based on the installation means and methods. Ultimately, the support points for the waterproofing were tightened up to 2 ft (0.6 m) on center and instead of chairs or bricks, plastic continuous upper beam bolsters were used to push back the membrane. These additional measures provided the best cost and quality benefit without dragging out the waterproofing installation.

Shotcrete Final Lining

BeMo was also instrumental in developing an application approach that used lattice girders to provide initial support to the wire mesh and provided a rigid shell to push back the PVC membrane. Lattice girders were erected at 5 ft on center and supported with longitudinal No. 5 (No. 16M) reinforcing bars at 2 ft on center. While serving in a structural capacity, the No. 5 bars also provided rigidity to the thinner mesh profiles to minimize vibrations and ensure good encapsulation. In select overhead areas where there was a gap larger than 4 in. (100 mm) between the girders and the membrane, an additional thin layer of non-structural W4/W4 welded wire fabric was installed directly against the membrane and blocked off the girders with chairs. This provided a supporting matrix against the membrane and facilitated the “buildup” of shotcrete. The structural wire mesh sections were installed between the girders and bolsters were used to push back/support the PVC membrane. A 6 in. layer of shotcrete was applied below the springline and over the crown along the lattice girders. This formed a series of overhead arches that could be used to support the remaining shotcrete. Once the arches had reached sufficient strength, the resulting bays were filled. The front of the girders were cleaned off and the second layer of mesh was installed. The second lift of shotcrete was applied to roughly 1 in. past the wire mesh. Note the mesh installation had to be carefully aligned and surveyed as it serves as the grade indication for the nozzlemen when they were approaching the desired profile.

For the final 2 in. polyfiber-reinforced layer, the shotcrete gun finish for the on-site mixture was sufficient from the crown to within 6 ft (1.8 m) of the walkway. From the walkway to 6 ft up the wall, a fine gradation mixture, MS-W1 from King Packaged Materials, was used. To achieve the desired

Fig. 5: Spraying secondary liner overhead arches on PVC waterproofing membrane

Fig. 6: Secondary liner overhead arches built up on lattice girders

smoothness and tight tolerances with the Potenza, a grid of fiberglass grade pins were installed on an offset 5 by 5 ft grid and at 1 ft (0.3 m) on center along the smoothing layer demarcation line. The grade pins were surveyed and cut to 1/2 in. (13 mm) inside the final profile.

SUMMARY

The Plymouth Tunnel was a unique opportunity to highlight the multiple benefits of shotcrete. Initial support shotcrete was able to be batched on site and provided quick support to the excavated face. The initial support shotcrete could be designed and quality controlled to meet permanent concrete standards and be included in the final design. Overbreak was recorded and the profile was controlled to minimize waste, expedite construction, and enhance the final tolerances. Additional supporting methods were evaluated in a full-scale mockup and used to enable the overhead robotic application of shotcrete on a PVC liner with minimal remedial grouting. The shotcrete equipment and workforce for the initial excavation were able to construct the final lining and still meet the watertightness and structural requirements of the permanent structure while leaving behind a unique aesthetic that is sure to be replicated soon.

Fig. 7: Spraying secondary liner bays between arches

Fig. 8: Plymouth Tunnel shotcrete final liner with form-and-pour invert

Fig. 9: Initial shotcrete application on PVC liner

2019 OUTSTANDING UNDERGROUND PROJECT

Project Name
Maryland Purple Line Plymouth Tunnel

Location
Silver Spring, MD

Shotcrete Contractor
Traylor Bros., Inc.*
(JV partner in the Purple Line Transit Constructors)

Architect/Engineer
Mott MacDonald

Material Supplier/Manufacturer
LafargeHolcim (cement), Sika (silica fume), Mapei* (admixtures)

Equipment Manufacturer
Advanced Concrete Technologies

General Contractor
Purple Line Transit Constructors (Fluor/Lane/Traylor JV)

Project Owner
Maryland Transportation Authority/ Purple Line Transit Partners

*Corporate Member of the American Shotcrete Association

Nick Tabor *is a Project Engineer with Traylor Bros., Inc. He worked with Traylor Bros. throughout his time at Purdue University, Lafayette, IN, where he received his BS in civil engineering in 2011 and obtained his professional engineering license in 2015. Tabor has been involved with many projects across the underground, heavy civil, and estimating divisions with experience in both design-build and public-private-partnership contracts. His recent experience includes the Blue Plains Tunnel, a 24,000 ft (7300 m) long, 26 ft (8 m) diameter EPB TBM CSO tunnel constructed in soft ground, and the Plymouth Tunnel, a 1020 ft (311 m) long, 27.33 ft (8.33 m) by 35 ft (11 m) horseshoe SEM/NATM transportation tunnel constructed in mixed face conditions. Tabor has experience with multiple facets of heavy civil underground construction from design development, coordination, and permitting through site setup, excavation, concrete/shotcrete works, and closeout. He is a member of UCA of SME, ASCE, and ACI, and serves as a professional mentor for the University of Maryland's Engineers without Borders.*

Norbert Fuegenschuh *attended the University of Technology, Graz, Austria, where he received his master's degree in civil engineering in 1989. He joined Beton- und Monierbau, now BeMo Tunnelling (short BeMo), located in Innsbruck, Austria, in 1990. Fuegenschuh began his professional career in the estimating department. After 1 year, he was transferred to Germany, where he spent a total of 10 years on subway and tunnel construction sites in charge of varying positions as quantity surveyor, deputy site manager, and site and project manager. In 2001, he became the Tunnel Manager at the Russia Wharf Tunnel project in Boston, MA. This was one of the first projects in the United States where a sprayed concrete inner lining was installed. He spent 2005 to 2011 in Sweden as Project Manager on two different tunnel projects and became BeMo Tunnelling's Area Manager for Scandinavia. Since 2011, he has served as President of Beton- und Monierbau USA, Inc., operating out of an office in Vienna, VA, and responsible for projects in the United States and Canada. Fuegenschuh has 30 years of experience in SEM/ NATM tunneling, including shotcreting works for tunnel primary and secondary linings. He is member of UCA of SME, the Tunneling Association of Canada, DFI's Underground Committee, and he also represents Austria in the International committee of the RETC.*

The latest projects with BeMo's involvement in North America include John Hart Generating Station in Campbell River, BC, Canada; China Town Station in San Francisco, CA; Quarters Tunnel LRT Project in Edmonton, AB, Canada; SEM cavern at Regional Connector in Los Angeles, CA; Plymouth Tunnel on Purple Line in Maryland; and Cross passages at Purple Line Westside extension, phase 1 in Los Angeles, CA.

2019 Honorable Mention

Ayla Golf Academy and Clubhouse

By Beat Huesler

Fig. 1: The building's rolling, dune-like form evokes the beauty of the surrounding desert and mountains
(Photo courtesy of Rory Gardiner)

For the Ayla Golf Academy and Clubhouse in Aqaba, Jordan, Oppenheim Architecture took inspiration from the surrounding landscape and Bedouin tradition to deliver a distinctive building that evokes the elemental beauty of the desert and mountains. The design makes innovative use of shotcrete to create a continuous shell that emerges from the sand as a set of rolling, dune-like forms. The 13,000 ft^2 (1200 m^2) building is a new landmark for the region and the architectural centerpiece of Ayla Oasis, a 19 mi^2 (49 km^2) leisure development currently under construction.

Fig. 2: A continuous shotcrete shell emerges from the sand, enveloping the volumes and defining the various program areas
(Photo courtesy of Rory Gardiner)

INTERIOR

Rather than traditional wall and roof structures, interior spaces are defined by undulations in the shotcreted concrete shell. The Clubhouse arrays retail areas, banquet halls, lounges, spa, and wellness components, while the Golf Academy includes retail, dining, and an indoor/outdoor swing analysis studio.

The design of the interiors takes its cues from Bedouin heritage. Sunlight filters through perforated corten steel screens that evoke Arabic mashrabiya, traditional window screens that introduce natural light to spaces without compromising privacy. Jordanian patterns inspired the triangular openings of the screens, while the colors of the surrounding mountains are echoed in the tones of the shotcrete and rustic metals. Throughout the building, curved openings frame glimpses of the golf course and the Aqaba Mountains. The interiors are finished in the same shotcrete as the exterior, creating a unified and aesthetically cohesive building.

SHOTCRETE ADVANTAGES

Shotcrete was crucial to achieving the building's complex, flowing geometries. Using it, Oppenheim was able to build the structure using native materials and local construction labor. The resulting building achieves its distinctive shape economically while retaining all the advantages of traditional concrete construction, including its strength, durability, and low permeability. Further, shotcrete made for a highly

Fig. 3: Perforated corten screens, inspired by traditional Arabic mashrabiya, introduce filtered sunlight to the interiors
(Photo courtesy of Rory Gardiner)

Fig. 4: The shotcrete was mixed with local materials and dyed with a pigment sourced from the nearby hills, further linking the building with the landscape
(Photo courtesy of Rory Gardiner)

sustainable building process by reducing construction time and minimizing the amount of formwork required.

Construction

A knowledge exchange program between Oppenheim Architecture's European office and the local workforce facilitated construction. Working closely with the Switzerland-based contractor Greuter AG, Oppenheim recruited and trained local Bedouin laborers in shotcrete construction. Taking into account the challenges that arise when using only locally available materials and a newly trained workforce, the design includes large shadow gaps in the windows to mitigate construction imperfections and centimeters of tolerance for the ceiling height.

To construct the building, individual section cuts were first taken from Oppenheim's computer-generated model and built on site with flexible thin-gauge steel ribbons. Then, the structure was reinforced with steel bars and an outer steel mesh. An adjustable blanket mesh and a layer of insulation were laid over the top of this structure, enveloping each of the volumes. Finally, concrete mixed with native materials and dyed with a pigment sourced from nearby hills was sprayed onto the structure. The resulting building—raw, unadorned, and monolithic—engages the surrounding landscape and pays homage to the region's architectural heritage.

The building was completed as part of Phase 1 of the Ayla Oasis development. The overall development will include residences, hotels, and commercial spaces, all centered around Jordan's first USPG tournament-rated golf course, designed by Greg Norman. Ayla Oasis is set to redefine Jordan as one of the world's most prestigious golf and leisure destinations.

About Oppenheim Architecture

Founded in 1999, Oppenheim Architecture is an architecture, planning, and interior design firm with an international portfolio of hospitality, commercial mixed-use, retail, and residential buildings. Each of Oppenheim's designs is fundamentally site-specific and deeply rooted in the spirit and traditions of its place. The firm's projects are crafted to establish the perfect balance between artistry and economics—timeless architecture that is as aesthetically pleasing as it is functional. With projects spanning over 25 countries, Oppenheim designs with sensitivity toward man and nature, harmonizing with the surroundings of each context. The firm's work has been published internationally in over 1000 publications including *The New York Times* and *Architectural Record*. The firm and its work has received over 70 distinctions, including more than 45 AIA Awards. Oppenheim Architecture is headquartered in Miami, FL, and has offices in New York and Basel, Switzerland.

***Beat Huesler**, Director of European Operations for Oppenheim Architecture, is a licensed architect with over 26 years of experience. Huesler has been integral in realizing several of the firm's projects, including the Ayla Golf Academy & Clubhouse and Comfort Stations, which received the Leisure Led Development Future Projects category award at the 2016 World Architecture Festival in Berlin, Germany. With his expertise in designing contemporary and sensitive interventions in historic structures, he received the Gutes Bauen in Kanton Baselstadt and Baselland Award 2002. Huesler is the European partner of Chad Oppenheim. Together, the two founded Oppenheim Architecture Europe in 2009. Huesler's relationship with Oppenheim extends back to their joint studies at Cornell University in New York, where Huesler received his Bachelor's and Master's of Architecture.*

2019 Honorable Mention

Project Name
Ayla Golf Academy & Clubhouse

Location
Aqaba, Jordan

Shotcrete Contractor
Greuter AG

Architect/Engineer
Oppenheim Architecture

Equipment Manufacturer
Nino Construction Engineers

General Contractor
Modern Tech Construction

Project Owner
Ayla Oasis Development Company

*Corporate Member of the American Shotcrete Association

2019 Honorable Mention

Duck Island Wastewater Treatment Plant: Screw Pump Rehabilitation

By Mason Guarino

The Duck Island Clean Water Facility, located in Lowell, MA, is a 32 million gal./day (120 megaliter/day) activated sludge treatment plant. The facility accepts wastewater from several Massachusetts cities and towns, including the City of Lowell and the towns of Chelmsford, Dracut, Tewksbury, and Tyngsborough. The service area includes approximately 220,000 people. The facility has been in the news for the past decade due to its need for massive repairs. During large rainstorms, it dumps thousands of gallons of less than properly treated water into the Merrimack river, which is a drinking water supply for many towns in the area. Starting in early 2018, the city awarded Waterline Industries (WI) a contract for full rehabilitation of the facility starting at the point of wastewater entry and working its way through the plant. Thus, the first-stage of repair would be the Archimedes screw pumps that convey the raw sewage from the sewer system up into the plant. South Shore Gunite (SSG) was retained to help with rehabilitation of the screw pumps, as SSG had worked on dam repair with Waterline Industries years before.

The screw pumps are 9 ft (2.7 m) diameter and 60 ft (18 m) long screw augers that sit in sloped concrete basin at a 45-degree angle. Each pump is capable of moving 30-million gal. (110 megaliter) of water per day. This facility has four screw pumps side-by-side which all required trench basin repair. The basin is a semi-circular shaped concrete

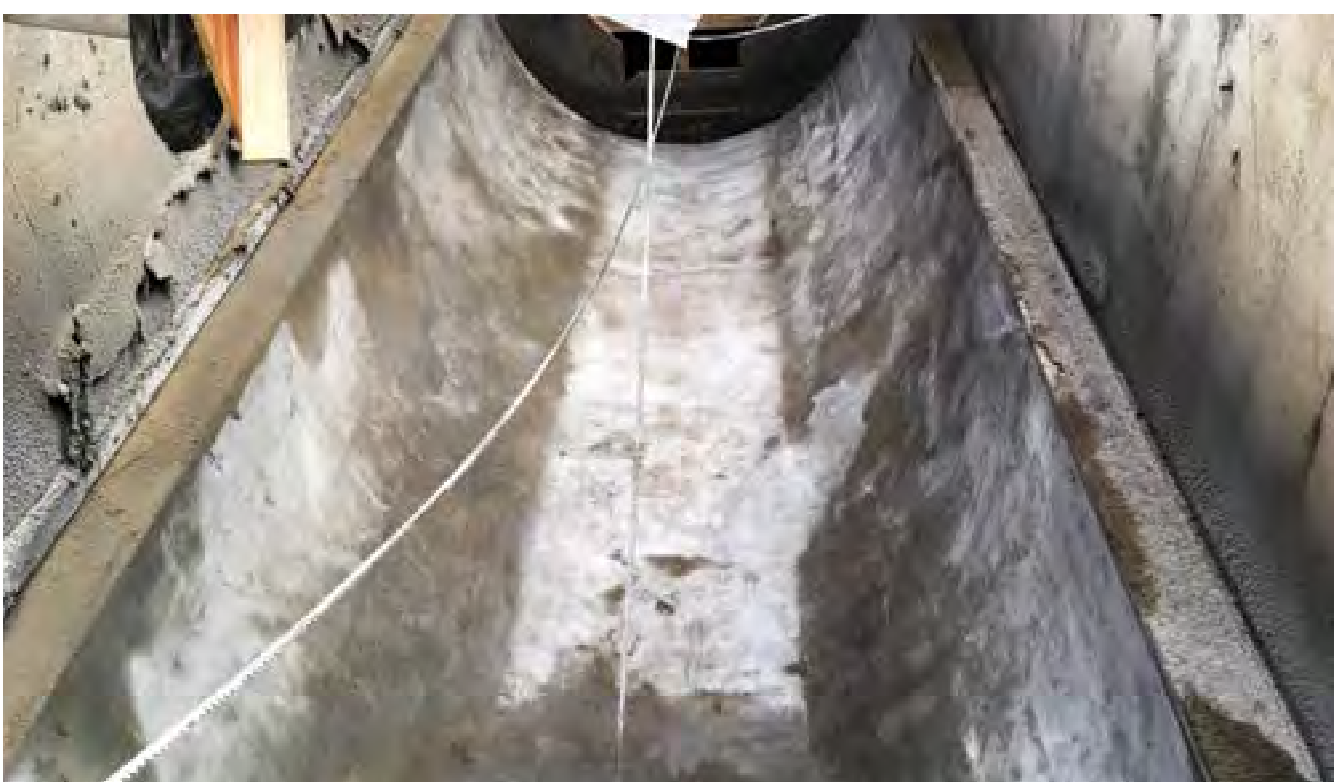


Fig. 1: Finished screw pump basin with tight radius

structure that is approximately 7/16 in. (11 mm) larger than screw flights. The tolerance between the screw and its supporting structure is very tight to ensure efficiency of the pump. The conventional way of repairing this structure is to remove the screw, demolish and remove the old grout lining down to the structural support, reinstall the screw with a 7/16 in. screed rod welded to the screw flights, and use the screw itself to screed the new concrete into place. The screw pumps at Duck Island are some of the largest, longest, and steepest in the country, making them some of the hardest to work on (Fig. 1).

FIRST CHUTE

During the demolition of the screw pump grout, it was found that the existing structure was 10 in. (250 mm) deeper than it should have been because the grouting operation with the screw only works with the grout being 2 to 3 in. (50 to 75 mm) thick. SSG was brought in to help build up the structure to match the 2 to 3 in. thickness that the grout needed. SSG asked WI to provide a plywood form top and bottom with a radius drawn to show where they wanted the shotcrete to stop. WI had all of this information and was able to easily provide SSG the radius and a couple of plywood templates to check the radius along the 60 ft shaft. SSG then drilled small holes in the template plywood every 10 in. along the line, and installed guidewires every 10 in. (Fig. 2). It took 4 days to set up and shoot the first chute. After SSG was done, WI checked SSG's work to confirm how much grout was needed, and was amazed to find that the installed shotcrete was accurate, with no noticeable variation anywhere. Additionally, the 28-day compression test results on the shotcrete came back over psi (55 MPa) with one panel breaking at 12,000 psi (83 MPa). They were impressed.

PROJECT CHALLENGES

In the following days, WI welded the 7/16 in. rod on the flights of the screw pump, reinstalled it, and performed the grout installation per the screw pump manufacturers recommendation. It did not go well. From SSG's shotcrete experience in the area, they knew that the local ready mixed concrete suppliers were not good at making the very-low slump concrete material this job required. The material showed up with mud balls in it and the grout did not stay in place when poured. WI spent 14 hours on site with 12 men struggling to get the screw grout installed, which still needed repair work afterward. A combination of the high-angle of this screw pump, and a concrete mixture that did not perform as needed, made for a very challenging, frustrating, and unrewarding day for WI. That's when SSG got a new request.

SSG was asked to install the shotcrete full-thickness to a tolerance of less than 1/8 in. (3 mm) deviation over 10 ft (3 m) on a radius structure. SSG said yes, but unfortunately, the engineer for the project and the screw pump manufacturer said no during a meeting with SSG, WI, the City, the engineer, and the screw pump manufacturer. Mason Guarino of SSG pools was asked if he could install shotcrete to the required tolerances to repair the screw pump lining and how he would do so. Guarino explained

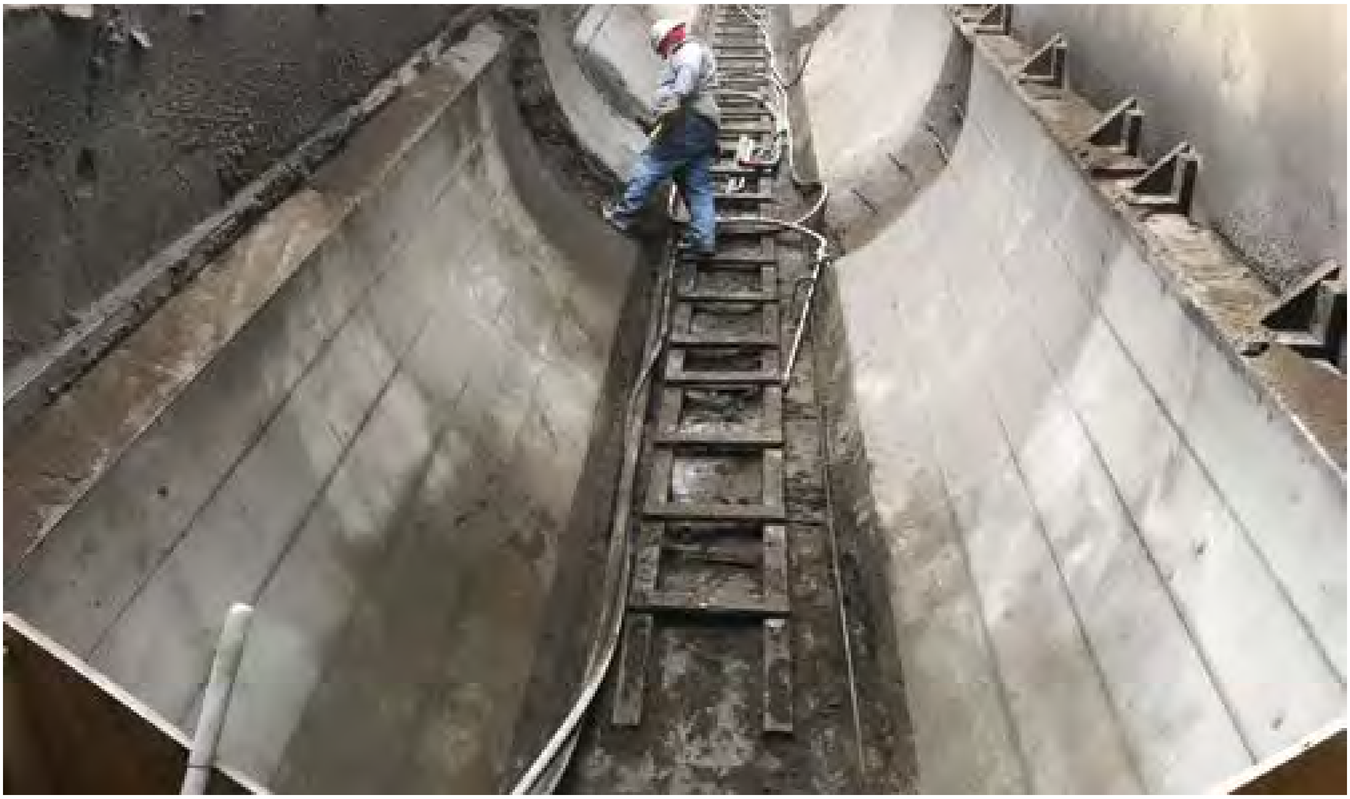


Fig. 2: Basin walls shot with guidewires in place

the shotcrete process, the benefits, and how we could achieve the desired results, but the engineer and manufacturer did not approve. The head of the plant argued that this process had failed three times in the past 10 years when this application of grout should last 20 years before repairs. The owner then went against the recommendation of the engineer and manufacturer and told WI and SSG to proceed with a full-thickness repair using shotcrete, and they did. In the following weeks, the engineer and pump manufacturer would not return calls or e-mails to WI or the owner.

SHOTCRETE SOLUTION

WI and SSG proceeded to work on repair of the next screw pump following the same procedure as the first one, building the shotcrete to the final finish elevation this time. SSG chose a specific pattern for the shotcrete placement that would ensure accuracy while maintaining production (Fig. 3). It would be easier to manage rebound and work from the top to the bottom of the screw, but the bottom is where all the rebound and water could accumulate, making it difficult to clean with the uneven surfaces from the demolition. The bottom sides were shot first (Fig. 4), along with the bottom middle on the setup day, but only up about 4 ft (1.2 m) to make rebound cleanup easier. Then SSG moved back to the top right, shooting about 10 ft of one side leaving a 3 ft (0.9 m) gap in the middle to provide us an area to walk in for finishing (Fig. 5). SSG then proceeded down from there, occasionally jumping from one side to the other, and skipping small areas where it had guidewire supports. The checkerboard-like pattern kept things moving so overspray was not hitting the finishers and SSG could work in smaller more manageable areas to ensure accuracy. The overall shooting process took 5 days to complete for one screw pump shaft. SSG hung a rubble bucket from a telehandler and set it to bucket down into the hole right where the rebound accumulated, so rebound management was relatively easy and saved the crew from manually carrying buckets of rebound.

Upon completion of the shotcrete work, the screw was installed the following week to check fitment and confirm that the shotcrete solution was the correct decision. When the screw was installed there was an initial concern because the screw was hitting the shotcrete. After further investigation it was found that in the previous repair, one of the 7/16 in. rods was not removed from the fight of the screw. Once removed, the screw spun freely as it was supposed to, and the tolerances appeared just as tight as they would have been with the conventional grout method. Upon testing, the flow of the screw was normal and some plant employees mentioned the screw with the shotcrete appeared to be conveying more water than the other screws.

Fig. 3: Careful trimming of the sides

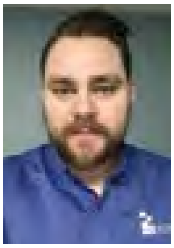
Fig. 4: Shooting side of basin off middle strip

Once the engineer and manufacturer heard about the success of the shotcrete, they became involved again and were more interested. SSG proceeded to work with WI for about a week every couple months to complete the remaining screw pump repairs. SSG used the dry-mix shotcrete method on this project because dry-mix allows a lower production rate, and facilitates stopping and starting throughout the day. Airplaco 914 mobile mixers were used to produce the material and SSG used a C-10 gunite gun to deliver material to the nozzle. The concrete material used was a dry-mix shotcrete mixture with a silica fume modified cement, concrete sand, and synthetic microfibers. The silica fume modified cement was chosen because SSG wanted to achieve high-strengths within just a few days as the plant was going to place the screw into operation within a week of completing the project. Curing was completed by keeping everything wet while SSG was on site, covering everything in poly plastic overnight and when SSG was not on site. A spray on curing membrane and surface hardener was used at the completion of the individual screw structure.

Fig. 5: Overview of shooting the basin with access down the middle

Conclusions

Shotcrete really transformed this from a difficult task that may not have performed well to a highly successful project. The monetary savings using the shotcrete method were negligible, but using shotcrete did help accelerate the project by 1 to 2 weeks per screw, and in an active wastewater treatment plant, days matter. When asked how shotcrete benefited this project from the general contractor's point of view, WI responded with "The quality of your final product and the structural integrity of the whole assembly is exponentially better than the multilayered system that has been traditionally done and which frequently needs to be redone due to the cold joints and multiple opportunities for poor concrete and grout conditions during installation." Overall it was a very successful project for SSG, the GC, owner, and shotcrete.



Mason Guarino *started in the pool industry when he was 14, learning how to install reinforcing bars. Since then, he has worked on all phases of swimming pool construction. Guarino has been with South Shore Gunite Pools & Spas, Inc., full-time since graduating from the Wentworth Institute of Technology with his BS in construction management in 2009. Guarino currently serves as Treasurer on ASA's Executive Committee and is an ACI Certified Nozzleman.*

2019 Honorable Mention

Project Name
Duck Island Screw Pump Rehabilitation

Location
Lowell, MA

Shotcrete Contractor
South Shore Gunite Pools & Spas, Inc.*

Architect/Engineer
Hazen and Sawyer

Materials Supplier
LafargeHolcim

Equipment Manufacturer
Gunite Supply & Equipment*

General Contractor
Waterline Industries

Project Owner
City of Lowell, MA

*Corporate Member of the American Shotcrete Association

2019 Honorable Mention

The Making of Swamp Thing

By Ryan Oakes

It was early November and I was on top of a mountain, at the halfway point of a project that would take 18 months to complete. This is the moment I got a call to help build a swamp, indoors, for a movie set on the coast. We get all sorts of odd requests, but this was a different kind of strange. Without further ado, I said, "Sure, sounds great, when do you need it?" The studio replied, "By Thanksgiving," as filming was starting the following week. This sort of answer required a little more digging.

The quick path to how we get there is this… The studio had just been given the green light for the upcoming series. They had strict deadlines to meet and if we wanted the job, we had to help them meet the deadlines. I questioned the practical nature of getting so much done in such little time, but this is the way the studio works, and we were soon to be their students and their heroes. They had artistic models underway, a plan in place, but no shortage of obstacles.

For starters, they wanted approximately 18,000 ft^2 (1700 m^2) of "swamp" to hold water approximately 4 ft (1.2 m) deep (Fig. 1). It was located indoors and all of the exposed surfaces had to be hand-carved to look like a muddy swamp bank (Fig. 2). With hundreds of feet of continuous carved concrete shoreline—it was the perfect job for shotcrete. The studio recognized this, and they called us.

What the studio didn't know was that using the shotcrete process, we could create a watertight concrete shell. They had already started construction of a stainless steel cofferdam around the project (Fig. 3) to help ensure that the lagoon would hold water for several seasons of filming. To complicate matters, they needed to demolish the structure after filming, so minimal to no reinforcing steel was desired. Finally, they wanted to color the exposed concrete surfaces to reduce artistic and post-production work, given the tight deadlines.

We had answers but not enough construction staff to get them over the finish line. We could shoot and carve it, but the studio would need to have all preparations, including any

Fig. 1: Finished Swamp Thing set

Fig. 2: Carved "mud" slopes

Fig. 3: Stainless steel cofferdam around set

formwork, ready for us when we arrived, as the project was on short notice with a very tight deadline.

To successfully complete this project, we needed to:

- Mobilize no earlier than November 12;
- Create a watertight shell;
- Carve muddy swamp banks with brown colored concrete;
- Create a black floor to disappear and create the illusion of depth with added reflection;
- Minimize or eliminate reinforcing bars to facilitate demolition;
- Connect to an existing deep well in the studio where divers could drop cars and swim with cameras; and
- Finish all work by November 21 (day before Thanksgiving) without fail.

PLASTIC SHRINKAGE

Sometimes it seems the stars line up perfectly—at least if you are prepared. It so happened that in the past year we produced three projects of incrementally larger size with varying shotcreted sections from 1 to 9 in. (25 to 225 mm) thick with no reinforcing steel.

We started with a small project of about 1200 ft^2 (110 m^2), then a 4100 ft^2 (380 m^2) commercial pool renovation, followed by the project we were working on at that time, which required so much rock carving that it would take a whole team of artists and rock climbers months to shoot and carve.

To help control plastic shrinkage without any steel, we placed concrete using natural fibers (hemp and jute). We had experimented with hemp fibers but couldn't procure enough in time for this project. So, I reached out to colleagues and found an answer in jute fibers (Fig. 4). These fibers came in various lengths and without having the research to determine which length would be best for us, we tried two different options on the Swamp project. Thankfully, we had the flexibility to do so. Throughout our 22 years of involvement

Fig. 4: Natural jute fibers in hopper

in various forms of construction, we have been able to experiment like this on several projects.

Why would control of early-age plastic shrinkage cracking be so important? In short, we needed a watertight shell. Any severe shrinkage cracking could create a path for water to flow through the section. Primarily, we shoot swimming pool shells, which also need to be watertight. It is common to see varied steel schedules in swimming pools or fountains, some of which are adequate and some that are not. The industry struggles with how to shoot a watertight shell with inadequate reinforcing steel. To that end, our company has been experimenting with natural fibers which are hydrophilic and help provide internal curing for the concrete. With the use of natural fibers, we have seen a substantial reduction in shrinkage cracks, regardless of span or lack of steel. With this result in mind, we explained to the studio that there were no guarantees, but that this addition to the mixture design should help achieve their goals.

In the end, we reduced the reinforcing bar in all of the vertical structures to a very light schedule and eliminated the reinforcing steel in the floor altogether.

ARTISTRY

How does one carve mud? The stars seemed to be aligned for us on this aspect, too. As swimming pool shotcrete finishers, we carve concrete every day, but those are straight walls, horizontal floors and benches, and even curved walls. We carve rockwork less often but mud, never. We even try to avoid it.. From time to time, however, we take on a man-made rock project and draw on talent from within our company, as well as outside. We use resources from our experiences and relationships that have developed over the decades. We know a wide variety of shotcrete artisans creating man-made rock. Most recently, we had hired a consulting firm, Ocean Rock Industries, out of British Columbia, that specializes in freehand carving and coloring for rock-like appearance using shotcrete placement. We had a group of experienced individuals, mostly rock climbers, who make a living as artists and whom I have climbed with and worked with for the last 25 years, but I felt we needed some enhanced skills. Thus, we hired Ocean Rock to introduce us to new techniques for creating shotcreted reproductions of natural rock. In this case, we were tasked to carve mud. We took on the challenge of the swamp project with professional artists Peter Glenn Oakley and Anne Rogers. Growing up in North Carolina and being familiar with the scene and applying simple techniques, we created the effects of muddy banks. We knew the studio would send in their artists on our heels, but we wanted to get them as close as possible during the shotcrete placement, given their limited time before filming.

We were shown where actors would be entering and exiting the water for various shoots, as well as where boats would be filmed, safety and camera divers would be, and how various action scenes would take place. It seems simple, but when you are tasked with making a path out of a concrete “swamp” for an actor to look like they are casually walking out of a muddy swamp rather than up a set of stairs, it takes a bit of thought and practice. Through understanding the buoyancy of an actor’s body in water, tread depth, and riser heights from shooting pools every day, and a general sense of artistry, we were able to create seamless transitions for the actors that didn’t look like stairs.

MONOLITHIC SHELL

One of the requirements of the project was that the concrete shell must hold water. We shot this shell over nine days with numerous construction joints (Fig. 5) throughout any given day and from the day before. Because the production schedule didn't allow for shooting breaks during the day, we had to move our shotcrete placement around a lot because we could only perform the artistic finishing component so fast.

To achieve a monolithic, watertight shell with many construction joints, we roughened the surface of the joints to achieve an International Concrete Repair Institute (ICRI) Concrete Surface Profile of 6 or higher. We typically use a grass cutting rake to achieve a rough surface. Once any of the surfaces were hardened, we water-cured all surfaces continuously with a garden hose. The curing water flowed off of the concrete into the diving well we shot on the first day (Fig. 6) and carried much of the rebound with it. At the end of the project, we vacuumed out all rebound slurry from the bottom of the diving well with a vacuum excavator truck.

The next step in shotcreting a monolithic shell with no cold joints requires cleaning the existing roughened surface, bringing the surface to a saturated surface dry (SSD) condition, and then properly shooting new shotcrete against the joint surface. To clean it, we either used a pressure washer, or simply shut down the material flow from the dry-mix nozzle and used the high-volume air flow with water to clean the surface. Using the dry-mix nozzle with only water and air also works well for cleanup. While shooting in congested or complex sections, it's important to use an air lance (Fig. 7), also referred to as a blowpipe, to keep the receiving surface clean and free from overspray or rebound.

Using these techniques allowed for hundreds of construction joints in over 18,000 ft^2 of watertight surface area. Though the studio had installed the steel coffer dam to ensure no water entered the rest of the building, they called us a week after the install and were happy to report that no water had yet to enter the space between the concrete shell and the coffer dam. Even months later on a site visit there was no evidence of leakage.

Timing

Hurricane Florence had just wiped out the coastal region of North Carolina, wreaking havoc up and down the coast. But,

Fig. 5: Various shooting locations around the swamp

Fig. 6: Deeper diving well

Fig. 7: Dry-mix shotcreting with air lance

Fig. 8: Final view of set with trees and ground debris

through an abundance of phone calls and plentiful preparation, we were able to organize this operation on time. Our aggregate pits were flooded, so we had to truck in aggregate from much further away. Gratefully, our satellite batching facility, which was only a few miles away from the studio, was large enough to store material for the job.

Though the local hotels were all booked due to the hurricane cleanup efforts, we were able to reserve enough rooms for our staff because we were regular hotel customers and had established good relationships in the area.

The jute fibers came air freighted from Korea and landed within days of our order, replete with enough of the two colors needed to integrate into our concrete mixture design for the job, thanks to a local color batching company and running our own flatbed truck.

Finally, nothing ever goes according to plan, so of course, we experienced a compressor failure. Thankfully, we had a backup and were able to supplement the backup with the only 950 ft^3/min. (27 m^3/min.) compressor rental within 300 miles (480 km).

One of the great things we learned about working with a studio is that they have an answer for everything. Minor cut? No problem, send a doctor over and get them back to work. Need a compressor? No problem, send one over. Remove rebound? No problem, they had bags, overhead cranes, and forklifts available all day. It was an amazing experience and they were essential to allowing us to complete the job in time (Fig. 8).

In 9 days, we placed over 18,000 ft^2 of colored and hand-carved concrete and finished just in time for everyone to make it home for Thanksgiving dinner. That's a wrap!

2019 HONORABLE MENTION

Project Name
The Making of Swamp Thing

Location
Wilmington, NC

Shotcrete Contractor
Revolution Gunite*

Architect/Engineer
Palladin Productions, LLC and Clearwater Construction Group

Materials Supplier
Natural Reinforce Fibers & Co.

Equipment Manufacturer
Gunite Supply & Equipment*

General Contractor
Studio Gems

Project Owner
Palladin Productions, LLC

*Corporate Member of the American Shotcrete Association

Ryan Oakes *is a Professional Watershape Designer and President of Clearwater Construction Group, Inc., Revolution Gunite, and Revolution Pool Finishes, all of which are award-winning firms in their respective trade. Oakes is a faculty member at Watershape University, where he continually aims to raise the bar in the swimming pool and the watershape construction industry. As a member of the leadership team for the International Watershape Institute (IWI) and through educational outreach to a vast pool builder network throughout the United States, he aims to improve the building techniques and methods of constructing swimming pools. Oakes is a member of ACI Committee 506, Shotcreting, and ACI Subcommittee 506-H, Shotcreting Pools. He serves on the ASA Board of Directors and also serves as Vice Chair of both the ASA Pool & Recreational Shotcrete Committee and the ASA Contractor Qualification Committee.*

2019 Carl E. Akeley Award

Akeley

Clements

Robertson

The 14th annual Carl E. Akeley Award was presented to William Clements and Kevin Robertson, King Packaged Materials Company, for their article, "Compatible Shotcrete Specifications and Repair Materials," published in *Shotcrete* magazine, Spring 2019. This article discusses how shotcrete is used for concrete repairs with correct test methods and using the right shotcrete material to provide a long service life.

ASA established the Carl E. Akeley Award 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.

References

1. Teichert, P., "Carl Akeley—A Tribute to the Founder of Shotcrete," *Shotcrete*, V. 4, No. 3, Summer 2002, pp. 10-12.

Kevin Robertson (second from left) accepting the 2019 Carl E. Akeley Award with Ryan Poole, ASA President (left); Ted Sofis, ASA member; and Charles Hanskat, ASA Executive Director (right)

PAST AKELEY AWARD RECIPIENTS

- 2006— Dufour, Reny, and Vézina, "State-of-the-Art Specification for Shotcrete Rehabilitation Projects"
- 2007—K. F. Garshol, "Watertight Permanent Shotcrete Linings in Tunneling and Underground Construction"
- 2008—E. S. Bernard, "Embrittlement of Fiber-Reinforced Shotcrete"
- 2009—Dufour, Lacroix, Morin, and Reny, "The Effects of Liquid Corrosion Inhibitor in Air-Entrained Dry-Mix Shotcrete"
- 2010—Dr. L. Zhang, "Is Shotcrete Sustainable?"
- 2011—C. S. Hanskat, "Shotcrete Testing—Who, Why, When, and How"
- 2012—R. Curtis White Jr., "Pineda Causeway Bridge Rehabilitation"
- 2013—Jolin, Nokken, and Sawoszczuk, "Sustainable Shotcrete Using Blast-Furnace Slag"
- 2014—Dr. L. Zhang, "Variability of Compressive Strength of Shotcrete in a Tunnel-Lining Project"
- 2015—E. Yurdakul and K.-A. Rieder, "Effect of Pozzolanic-Based Rheology Control Agent as a Replacement for Silica Fume"
- 2016—M. von der Hofen, "East End Crossing"
- 2017—Axel Nitschke, "Modeling of Load-Bearing Behavior of Fiber-Reinforced Concrete Tunnel Linings"
- 2018—Kyong-Ku Yun, "Cellular Sprayed Concrete"

2019 ASA President's Award


Cotter

The ASA President's Award was established in 2005 to recognize a person or organization that has made exceptional contributions to the shotcrete industry. It is the sole responsibility of the immediate outgoing President of ASA to select the recipient of this award. Since 2006, 13 well-deserving individuals and one organization have been awarded the ASA President's Award, all of whom dedicated their time and energy to advancing the shotcrete industry.

For 2019, at the Fifteenth Annual ASA Awards Banquet in Las Vegas, NV, the immediate outgoing President of ASA, Cathy Burkert, presented this award to Michael Cotter, for his exemplary leadership in the shotcrete industry, advancing and facilitating the mission of ASA.

> *"This person has been in the construction industry for over 40 years. He has owned a construction and consulting business and has repaired over 10,000 structures, placing over a million ft^2 of shotcrete in his career. Shortly after ASA was established, this person became increasingly involved and served on numerous committees, the Board of Directors, the Executive Committee, and in 2013 served as ASA's President. He has shown significant leadership and commitment to ASA throughout the years and is a wealth of knowledge when it comes to shotcrete practices.*
>
> *This person set out to substantially improve the nozzleman certification program and was a prime mover in developing the ASA Shotcrete Contractor Qualification program. While this person has moved out of active company participation and into a well-deserved retirement, he still serves ASA as a member of the Contractor Qualification Committee.*
>
> *A lot of you had the opportunity to sit in meetings throughout the years with this person and many of you may have gotten into some heated discussions. But as one who has worked for years with him, I can say he truly respects all of you and considers you lifelong friends. One of his favorite metaphors is "without an agitator, the wash doesn't come clean." This person first introduced me to ASA over 15 years ago and has been my source of inspiration and motivation working under his leadership. As my mentor and my friend, I am proud to present this year's ASA President's Award to Mr. Michael Cotter."*
>
> —Cathy Burkert

Cathy Burkert, ASA Past President, presenting the 2019 ASA President's Award at the ASA Awards Banquet

ASA IS MOVING!

As announced in the last issue, ASA will be transitioning to a new association management company this year. Effective March 1, 2020, please note our new contact information:

- Headquarters: 25 Century Blvd., Suite 505, Nashville, TN 37214;
- Main Phone number: 248.963.0210; and
- E-mail: info@shotcrete.org as well as Charles.Hanskat@shotcrete.org and Alice.McComas@shotcrete.org will remain the same.

This is a significant move for ASA, and we appreciate your patience during our transition.

WORLD OF CONCRETE 2020

Always a great venue to bring together old and new partners, World of Concrete (WOC) 2020 provided another great opportunity to connect and offer ASA's educational resources to the shotcrete community. Each year seems to bring new and/or greater interest in information on shotcrete. ASA's co-sponsorship of the show allows us to offer the lowest possible rate for exhibit-only passes. We encourage our members to help promote these discounts to their clients for future shows to take advantage of all WOC has to offer. Please remember to like and share our social media posts on the various classes offered for all our postings. This helps ASA spread the word and the more people who take advantage of ASA resources at venues like WOC, the better the industry benefits from higher quality and safer practices of shotcrete application. This boosts shotcrete's reputation and benefits us all as shotcrete gains increased acceptance and even preference in the industry!

This year's General Membership Meeting was very well attended on Monday afternoon, before the show started. What a nice nod to the level of interest in the Association's operations as Executive Director, Charles Hanskat, recapped ASA's activities for 2019 and introduced the new slate of elected officers for 2020, both are summarized elsewhere in this issue (see Executive Director's Update on page xx and ASA's Officer and Board of Directors' appointments later in this column).

Immediately following the membership meeting, ASA Board members Frank Townsend and Marcus von der Hofen presented a 90-minute seminar: "Shotcrete Technology for Diverse & Cost-Saving Projects." Both are dynamic speakers and brought an energetic and informative presentation to a packed audience.

ASA's Shotcrete Nozzleman Education, a prerequisite for those pursuing ACI Shotcrete Nozzleman certification, saw great attendance on Tuesday. Member company HydroArch again hosted the written and performance exams for ACI Wet-Mix Certification in nearby Henderson, NV, later that week. Having this regular opportunity to certify or recertify at WOC has been a great means to enable companies with only a couple of nozzlemen who are already attending WOC, to gain/renew their certifications. We anticipate this opportunity to be available next year as well.

ASA's recently launched Contractor Education, the seminar component to ASA's Contractor Qualification program, also saw great attendance at this year's show. This is an excellent education for the Shotcrete Contractor looking for best practices for their company, recognizing that it takes more than a certified nozzleman to produce quality shotcrete projects. It takes a seasoned and dedicated crew, backed by a company willing to invest in the necessary resources to implement exceptional work. It is this dedication that helps raise the bar and betters the shotcrete industry for all of us. It is very rewarding to see so many in our industry who are passionate about their work and seek to perform at this level!

Finally, ASA member and examiner Raul Bracamontes provided a 4-hour industry class on "Shotcrete Problems and Their Causes" in a Spanish-only seminar. We continue to see great interest in the Spanish community for shotcrete information and nozzleman certification. ASA conducted two classes recently in Mexico and have had requests for more from Mexico, Peru, and Guatemala. ASA offers Spanish resources on our website and in 2019 began the practice of including a Spanish translated article in each issue of *Shotcrete* magazine. Informacion disponible en español (Spanish Resources) at **www.shotcrete.org/pages/products-services/spanish-resources.htm**.

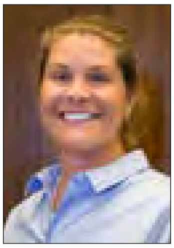
2020 ASA OFFICERS AND BOARD OF DIRECTORS APPOINTMENTS

ASA announced its new officers and Board members who were elected by membership. Ryan Poole, Consultant, will serve a 1-year term as ASA President. Cathy Burkert, American Concrete Restorations Inc., assumes the position of Past President.

To complete the Executive Committee, the ASA membership also elected the following for 1-year terms: Lars Balck, Consultant, as Vice President; Axel Nitschke, WSP USA, as Secretary; and Mason Guarino, South Shore Gunite Pools & Spas, Inc., as Treasurer.

Newly elected ASA Directors to serve 3-year terms include Juanjose Armenta-Aguirre, Texan Gunite; and returning for a second 3-year term: Jonathan Dongell, Pebble Technologies, and Marcus von der Hofen, Coastal Gunite Construction Company.


Poole


Burkert


Balck


Nitschke


Guarino


Armenta-Aguirre

Returning ASA Directors include Oscar Duckworth, Valley Concrete Services; William Geers, Bekaert; Jason Myers, Dees-Hennessey Inc; Ryan Oakes, Revolution Gunite; Mike Reeves, Gunite Specialists Inc; and Frank Townsend, Superior Gunite. To support the mission and work of ASA, the following individuals serve as Chairs of ASA Committees: Marcus von der Hofen, Coastal Gunite Construction Company, Contractor Qualification Committee; Oscar Duckworth, Valley Concrete Services, Education Committee; Dennis Bittner, The Quikrete Companies, Marketing Committee (Newly appointed); Jason Myers, Dees-Hennessey Inc., Membership Committee; Mason Guarino, South Shore Gunite Pools & Spas, Inc., Pool and Recreational Committee; Frank Townsend, Superior Gunite, Safety Committee; Lihe “John” Zhang, LZhang Consulting & Testing Ltd., Technical Committee; and Axel Nitschke, WSP USA, Underground Committee. Committee meetings are open to the public and ASA welcomes and encourages the participation of all interested parties in the shotcrete industry. The next committee meetings are scheduled for March 28, 2020, immediately preceding the Spring ACI Concrete Convention in Rosemont, IL. For more information, visit **www.shotcrete.org**.

2020 OUTSTANDING SHOTCRETE PROJECTS AWARDS BANQUET

The 2019 Award winners were announced and celebrated at this year’s Outstanding Shotcrete Project Awards Program at the Vdara Hotel & Spa in Las Vegas, NV. Returning to a favorite venue, attendees enjoyed a fabulous meal, exceptional networking, and a host of outstanding project presentations! This year’s awardees, featured throughout this magazine, shared all the ways shotcrete made their projects shine. It was a great evening and truly a capstone event for the shotcrete industry as we celebrated your outstanding accomplishments.

ASA also took a moment to recognize the original ASA Marketing Chair, co-creator and Master of Ceremonies for the Awards program and banquet, Joe Hutter. He led the efforts for the creation of this program and seen it recognized as the vibrant, distinguished program it is today. Hutter had been the banquet MC for the first 13 years of

2019 OUTSTANDING SHOTCRETE PROJECT AWARD WINNERS

CATEGORY	PROJECT
Architecture | New Construction	**Uber Mission Bay Tower Terraces**
Infrastructure	**1395 22nd Street**
International	**Pretoria Entrance Canopy**
Pool & Recreational	**Purlear Creek**
Repair & Rehabilitation	**Falls Village Penstock #1 Structural Shotcrete Rehabilitation Project**
Underground	**Maryland Purple Line Plymouth Tunnel**
Honorable Mention	**Ayla Golf Academy & Clubhouse**
Honorable Mention	**Duck Island Screw Pump Rehabilitation**
Honorable Mention	**The Making of Swamp Thing**


Vdara

2019 ASA OUTSTANDING SHOTCRETE PROJECT AWARDS BANQUET

Joe Hutter (left) with his wife Janet Hutter and longtime ASA members Bill Drakeley and Scott Rand (right)

the program and ASA wanted to recognize his tremendous contribution to the growth and success of this program. Hutter will be retiring from King, a Sika Company, and joined by his wife Janet, enjoyed this year's banquet as a guest for the first time. Thank you, Joe Hutter, for your great service to ASA over the years!

A hearty THANK YOU is extended to this year's Big Shooter, Gold, and Silver Sponsors, listed on pages 12-14! ASA is indebted to their generous support of the Awards program and the work of the Association. ASA recognized our sponsors at the banquet, in our WOC booth, on our website, in our eNewsletter, via press releases, social media outlets, and in *Shotcrete* magazine because they are leaders in their fields and demonstrate their commitment to the industry by supporting programs that highlight the excellent work possible through shotcrete. ASA invites others to join in as sponsors next year, as this investment has helped ASA grow to be the influence maker it is today for the shotcrete community!

2019-2020 ASA GRADUATE SCHOLARSHIP AWARDED

Germain

The 2019-2020 ASA Graduate Scholarship was awarded to Thomas Germain. He received a stipend of $3000 (USD) for tuition, residence, books, and materials. His bio and a summary of his research project can be found on page 10 of this issue. Our annual graduate scholarship provides a scholarship to a Laval University graduate student engaged in shotcrete research. Evaluation of the entries includes a review of the relevance of the project's objectives with regards to the needs of the shotcrete industry, quality, originality and scope of the research project, and integration of sustainability elements in the project. Laval University has been a leader in shotcrete research and ASA recognizes and supports their contributions to the industry through this scholarship and funding of other research needs.

CALL FOR PRESENTATIONS FOR ASA'S SHOTCRETE CONVENTION & TECHNOLOGY CONFERENCE

February 21-23, 2021
Sonesta Hotel & Resorts | Hilton Head, SC

SHOTCRETE CONVENTION &
TECHNOLOGY CONFERENCE

ASA is pleased to confirm the dates and location for our next Convention in 2021. The Call for Presentations will open in April. Please look for the announcement via our eNewsletter and social media platforms. ASA's Shotcrete Conventions provide a unique opportunity for leaders in the shotcrete industry to receive a variety of shotcrete-focused seminar options while meeting key players in the industry and learning from each other.

CALL FOR ENTRIES FOR 2020 OUTSTANDING SHOTCRETE PROJECT AWARDS PROGRAM

ASA will begin accepting applications for it 2020 Outstanding Shotcrete Project Awards program in April 2020. These awards confirm and demonstrate the exceptional advantages of shotcrete placement of concrete. Awards are bestowed in the following six categories: architecture/new construction, infrastructure, international projects, pool & recreational, rehabilitation & repair, and underground. The deadline for submissions is October 1, 2020. For more information about the Outstanding Shotcrete Projects Awards and to view past award-winning projects, visit **www.shotcrete.org/ASAOutstandingProjects**, or contact us at info@shotcrete.org.

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COASTAL GUNITE CONSTRUCTION COMPANY—CORPORATE MANAGEMENT CHANGES

Coastal Gunite Construction Company of Bradenton, FL, and Cambridge, MD, announced corporate management changes and promotions as well as the incorporation of new and exciting corporate directions. The 37-year-old firm has continued its evolution from a construction firm focused primarily on dry-mix shotcrete to include alternate methods of rehabilitation. Coastal Gunite now offers not only wet and dry-mix shotcrete but also full-service structure rehabilitation. This “one stop shop” for bridge superstructure and substructure rehabilitation includes spray-applied molten-zinc anode for cathodic protection, impressed current cathodic protection pile jackets, and embedded anode protection. Coastal Gunite is also an approved installer for carbon fiber sheet external reinforcing, beam post-tensioning, and epoxy crack injection. Its pipe and culvert division can rehabilitate large and small pipes, culverts, storm sewers, and sanitary sewers using the most cost-effective process for each project.


White

Long-time President and Founder **Curt White** has moved to Chairman of the Board and CEO of the company and will continue to provide long-range planning and oversight.


Emmrich

Randle Emmrich, most recently Vice President, was named President. She has worked for Coastal Gunite for 24 years since receiving her civil engineering degree cum laude from Bucknell University, Lewisburg, PA. She has worked as a Salesperson, Project Engineer, Project Manager, and Vice President. Randle is a member of ASA Marketing and Membership Committees.


von der Hofen

Marcus von der Hofen was named Executive Vice President and Chief Operating Officer (COO). von der Hofen has worked for Coastal Gunite for 9 years in the capacity of Vice President and COO. He attended Washington State University, Pullman, WA, and has over 32 years of experience in the industry as estimator, project manager, and area manager. He is Chair of the ASA Contractor Qualification Committee and also serves as a member of the ASA Education, Marketing, Membership, Pool & Recreational Shotcrete, Safety, and Underground Committees.


Emmrich

Martin Emmrich was named Vice President. Martin has worked for Coastal Gunite for 11 years as Project Manager and Area Manager. He completed undergraduate work at the University of California, Santa Barbara, Santa Barbara, CA, and his masters degree at Duke University, Durham, NC. He worked as a consultant prior to joining Coastal Gunite.

Coastal Gunite is confident that with its evolution of leadership, it will continue its positive role in the shotcrete industry. As a Charter Member of the American Shotcrete Association, a Sustaining Corporate Member of ASA, and as one of the first ASA Qualified Contractors, Coastal Gunite looks forward to participating as a leader in this vibrant sector of the economy.

For more information, call 941.744.5500 or visit **https://coastalgunite.com**.

BEKAERT TAKES FULL OWNERSHIP OF BEKAERT MACCAFERRI UNDERGROUND SOLUTIONS

On October 31, 2019, Bekaert concluded the buy-out of Maccaferri’s 50% share in Bekaert Maccaferri Underground Solutions. As a result, the Underground Solutions team will from January 2020 onward work under the Bekaert name. Customers will not notice any difference in service level. Bekaert will continue providing the same quality products such as Dramix®, Duomix®, Synmix®, and services.

The current team of underground solutions experts continues to provide technical guidance and support in the reinforcement of concrete in underground construction projects, such as shotcrete and precast applications.

For more information, visit **www.bekaert.com**.

VOLUMECH, LTD TO JOIN CEMEN TECH INC. FAMILY

Cemen Tech acquired Volumech, LTD, which currently provides replacement parts for several makes of volumetric mixers, site service, and mixer refurbishments. Volumech will be combined with Cemen Tech’s existing operations in the UK and operate as Volumech, A Cemen Tech Company.

In the future, Volumech will be the only source in the UK for Genuine Cemen Tech parts as well as new Cemen Tech mixers. Volumech will continue to provide aftermarket replacement parts which meet or exceed OEM standards for several makes of mixers as well as on-site service and mixer refurbishments. The new entity will have two locations: Volumech’s current location at 90 Bristol Road, Gloucester, and the existing Cemen Tech facility on Wyvern Ave in Stockport. The merged entity will allow Volumech to provide unparalleled support for not only Cemen Tech customers, but operators of all volumetric mixers across the life of their equipment.

For more information, call 800.247.2464 or **www.cementech.com**.

ACI FOUNDATION'S STRATEGIC DEVELOPMENT COUNCIL ANNOUNCES NEW DIRECTOR

The ACI Foundation's Strategic Development Council (SDC) announced new and returning board members.

Phil Diekemper was elected Director for the term ending in 2022. Diekemper is the Vice President of North Operations at CECO Concrete Construction, LLC, and has been with CECO for more than 41 years. Diekemper received his BS in civil engineering (structures) from the University of Illinois and his master's in marketing from Seattle University, Seattle, WA. He has participated as a specialty subcontractor on over 400 cast-in-place concrete building projects. He has served on the Board of Directors for Building Contractors Association of New Jersey, Builders Association of Greater Chicago, and Builders Association Scholarship Foundation; was the Vice President for The Cement League – New York City; and other positions at several other industry organizations.

Claude Bedard is a returning Director. Bedard is the President of Euclid Admixture Canada Inc. and the Vice President of The Euclid Chemical Co. Bedard has over 35 years of experience in the industry. He received his bachelor's degree, master's degree, and PhD in civil engineering from Université de Sherbrooke, Sherbrooke, QC, Canada. Bedard is Past Chair of SDC and a member of the ACI Foundation's Concrete Research Council (CRC). He has also served on the former Technology Transfer Advisory Committee; ACI Committees 212, Chemical Admixtures, and 237, Self-Consolidating Concrete; and as a member and Past President of Québec Chapter – ACI.

Other board members include **Charles S. Hanskat**, Chair; **Joseph C. Sanders**, Immediate Past Chair; **Kirk Burns**; **Rodney J. Chiodo**; **Beverly A. Garnant**; **John L. Hausfeld**; **Carl J. Larosche**; **Brad Malmsten**; **Claudio E. Manissero**; **Charles K. Nmai**; and **Glenn E. Schaefer**.

For more information, call 248.848.3737 or visit **acifoundation.org/technology**.

ACI CELEBRATES CERTIFICATION PROGRAMS AT WORLD OF CONCRETE

ACI hosted a celebratory booth event in honor of ACI Certification at World of Concrete in Las Vegas, NV. Attendees were invited to attend the event to learn about recent ACI Certification achievements and network with leadership, staff, and ACI Sponsoring Groups.

John W. Nehasil, ACI Managing Director, Certification, spoke on the Institute's nearly 40-year history of certifying more than 550,000 craftsmen, technicians, inspectors, and other concrete professionals; announced the launch of the first British Standards/European Norms-based ACI certification program; highlighted updated naming and requirements for the concrete Flatwork Finishing program; and introduced several new programs including: Post-Installed Concrete Anchor Installation Inspector; Shotcrete Inspector; Concrete Construction Sustainability and Resilience Assessor; and Non-Destructive Testing Specialist I – Concrete Strength.

During his remarks, Nehasil walked attendees through the ACI Certification Verify app, a new tool allowing users to quickly and easily verify the status of ACI-certified individuals. In addition, he brought attention to the Institute's Veteran Rebate program, an effort to assist U.S. veterans in obtaining ACI certifications. Honorably discharged U.S. military veterans attaining ACI certification in any program as the result of exams administered through any ACI Certification Sponsoring Group are eligible to apply for a $250 rebate from the ACI Foundation. These rebates will be distributed by the ACI Foundation as long as funding remains available.

For more information, visit **www.concrete.org/certification/veteranrebate**.

"ACI Certification continues to provide industry-leading credentials for concrete craftsmen, technicians, inspectors, and other concrete professionals," stated Nehasil. "The development and launch of new programs, the ACI Certification Verify app, and the veteran rebate program are key indicators of the impact ACI Certification continues to make on the concrete construction industry."

For more information, call 248.848.3790 or visit **ACICertification.org**.

ACI ANNOUNCES RECIPIENTS OF ACI CONSTRUCTION AWARD

The ACI Construction Award was awarded to James Klinger, Tim Manherz, Bruce A. Suprenant, and Frank P. Salzano for their paper: "Constructability of Embedded Steel Plates in Cast-in-Place Concrete," *Concrete International*, September 2018, pp. 28-34. The article presents recommendations for best practices for design, fabrication, coordination, and construction of embedded steel plates in cast-in-place concrete.

James Klinger is a Technical Representative for the Conco Companies, based in the San Francisco, CA area. **Tim Manherz** is the Senior Vice President of Operations at TAS Commercial Concrete Construction, with headquarters in Houston, TX. **Bruce A. Suprenant** is the Technical Director at the American Society of Concrete Contractors (ASCC) located in St. Louis, MO. **Frank P. Salzano**, is Director of Quality Control at Ceco Concrete Construction. For more information, visit **https://concrete.org/aboutaci/honorsandawards/awards.aspx**.

CALL FOR PAPERS FOR THE SHOTCRETE CONFERENCE AND EXHIBITION 2021

öbv österreichische bautechnik vereinigung

The Austrian Society for Construction Technology issued a call for papers for The Shotcrete Conference and Exhibition 2021 to take place in Alpbach/Tyrol, Austria, on January 21-22, 2021. This conference has gathered shotcrete specialists for 30 years, in a venue to provide easy exchange of knowledge and networking opportunities. The location will be at the Alpbach Conference Centre located in the central Alps.

Authors are requested to submit a 100-word abstract, which will be the basis for a preliminary acceptance by the Scientific Committee. Abstracts should be submitted by e-mail to spritzbeton@kusterle.net as a MS word file by April 2, 2020. Full papers must be submitted by July 1, 2020. The final program will be published by October 19, 2020.

The conference language will be in German. Some presentations will be in English. In addition, English summaries of all presentations will be available.

The Conference Chairs include Robert Galler, Montan

Universität Leoben; Gerald Goger, TU Vienna; and Wolfgang Kusterle, OTH Regensburg.

For more information, visit **www.spritzbeton-tagung.com**.

ICRI ELECTS NEW OFFICERS AND BOARD MEMBERS

The International Concrete Repair Institute (ICRI) announced the election new officers and board members for the calendar year 2020 and **Mark LeMay** with JQ Engineering as its President. To support LeMay, the ICRI membership also elected officers including **Elena Kessi**, Aquafin Building Product Systems, President-Elect; **John McDougall**, Baker Roofing Co., Inc., Vice President; **Brian MacNeil**, Kryton International Inc., Treasurer; and **Pierre Hébert**, Secretary. **Chris Lippmann**, HDSupply, served as 2019 President and will continue his service on the board as Immediate Past-President. Their terms began on January 1, 2020 for a 1-year period.

Mark Nelson will continue to serve as an ex-officio member of the Executive Committee in his role as Chair of the Technical Activities Committee (TAC).

In addition to the President and Officers, new members began serving 3-year terms on January 1, 2020 ending on December 31, 2022, including **Paul Farrell**, Carolina Restoration & Waterproofing, Inc. (Region 2); **Jon Connealy**, Logan Contractors Supply, Inc. (Region 5); **Dennis Wipf,** Gervasio & Associates Inc. (Region 8); **Ashish Dubey**, USG Corporation (At Large); and **Liying Jiang**, Simpson Gumpertz & Heger, Inc. (At Large).

The returning board members whose terms were not up for re-election with terms ending in 2020 include **Jason Coleman**, O'Donnell & Naccarato, Inc.; **Pete Haveron**, Texas Concrete Restoration, Inc.; **Adam Hibshman**, Valcourt Exterior Building Services; and **Ingrid Rodriguez**, Ingrid Shawn Cooperation. Returning board members with terms ending in 2021 include **Pat Gallagher**, PULLMAN; **Dan Wald**, BASF Construction Systems; **Jim Spiegel**, Alchemy-Spetec; **Rick Edelson**, Edelson Consulting Group, LLC; and **David Marofsky**, MAPEI Corporation.

For more information, call 651.366.6095 or visit **www.icri.org**.

SHOTCRETE FAQs

As a service to our readers, each issue of *Shotcrete* magazine will include selected questions and provide answers by the American Shotcrete Association (ASA). Questions can be submitted to info@shotcrete.org. Selected FAQs can also be found on the ASA website at http://shotcrete.org/pages/products-services/technical-questions.htm.

Question: *I live in a 10-story condo building built in the 1960s. The entire building is made of gunite. We use masonry drill bits for holes, but nothing seems to grip well. We have tried concrete screws, metal drywall anchors (which seem to work the best), and a plethora of other anchors and screws, but nothing seems to work. They all cause mushrooming and they either don't grip or turn the wall to powder. What are the best tools to affix things to the walls?*

Answer: Shotcrete is a placement method for concrete. Dry-mix shotcrete (the old tradename is gunite) using proper materials, equipment, and application techniques should have easily been able to reach a strength of 4000 psi (28 MPa) in the first month. After 10 years in-place the concrete should be even stronger. The level of concrete strength developed by quality shotcrete should easily accommodate drilling in anchors or concrete screws. In my experience it would have been highly unusual to build an entire 10-story building with shotcrete even in the 1960s. I'd suggest based on the extremely weak material properties and the wall turning to dust what you think is shotcrete may be sprayed plaster or stucco. Those materials don't have near the same strength as shotcrete and would exhibit many of the problems you have mentioned.

Question: *Do you have any reference documentation for the application of using concrete stamps/textures or hand carving on vertical shotcrete applications for architectural finishes?*

Answer: Unfortunately, I'm not aware of any specific references to guide you in stamping or carving of fresh shotcrete for vertical surfaces. In many ways carving and stamping is a technique that requires more of an artistic flare that a finisher develops by hands-on experience. One key aspect is to minimize the working of the surface as much as possible to prevent tearing or delaminating the shotcrete surface layers. Carving or stamping when the concrete has reached an appropriate level of set (not too hard or soft) must also be judged by the experienced shotcrete finisher.

Question: *Can shotcrete be considered as structural concrete with wire mesh and rockbolts in tunnel linings?*

Answer: Shotcrete is a placement method for concrete. It is routinely used for a wide variety of structural applications. It has been used for both initial and final linings in tunnels where it is commonly reinforced with wire mesh, fibers, or reinforcing steel. You may want to review our past *Shotcrete* magazine articles on tunnel shotcrete at **shotcrete.org/archivesearch** using keywords such as "tunnel," "underground," and "linings." Also, we have two position papers from our underground committee: "Spraying Shotcrete Overhead in Underground Applications," and "Spraying Shotcrete on Synthetic Sheet Waterproofing Membranes," that you may find informative. Also, ACI 506.5R-09, "Guide for Specifying Underground Shotcrete," can provide insight into topics important for using and specifying underground shotcrete.

SUSTAINING CORPORATE MEMBER PROFILE

BUESING
Civil Engineering Contractor
ROC# A-200645 ROC# A-293015

Buesing Corp has been a specialty civil contractor since 1965 initially in Long Lake, MN, and since 1986 and now only in Arizona. Buesing is a robust medium size subcontractor with annual revenues exceeding $50 million, with more than 200 employees and 225 pieces of equipment, mostly owned. Its employees have strong experience, skill, and professionalism, and are integral to Buesing's reputation of being innovative and project problem solvers. Buesing takes pride in its customer service and strives for repeat business and lasting relationships.

The company performs work under many types of contracts, including conventional competitive design-bid-build, design-build, negotiated, construction manager at risk (CMAR), and integrated project delivery (IPD).

Although the majority of Buesing's work is performed as a subcontractor, sometimes the company performs work as the prime or general contractor when there is an appropriate scope and bid opportunity.

Buesing was selected as *ENR* Southwest Regional Specialty Contractor of the Year in 2018.

SERVICES

Buesing provides a variety of services and its employees have commensurate experience, skill, and cross-training to exceed customer expectations. Services provided (but not limited to) include shotcrete, shoring (earth retention), mass excavation, site grading, import/export soil, aggregates, material transport/trucking, recycling concrete and asphalt, foundation drilling, and site concrete/amenity hardscape.

Fig. 1: Aerial view of basement soil nail shoring and radius wall

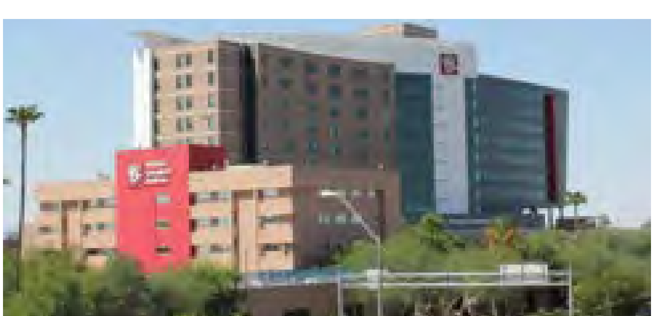

Fig. 2: Completed Phoenix Children's Hospital project

The majority of services provided are either under a multi-service contract or ancillary or independent work. For example, its shoring crews often will work on Buesing's construction projects and then, as needed, perform work as an independent service with other contractors.

MARKET SECTORS

Buesing serves a number of market sectors which highlights the diversity of its experience, including commercial/mixed-use, multi-family/apartments, condos, residential (single-family home master-planned communities), hospitality, healthcare, transportation/highway/DOT, water/wastewater, industrial/warehouse/manufacturing, stormwater/flood control, landfills, and mining.

Given the increase in development and construction activity over the past couple years, Buesing serves six to seven market sectors at the same time in any given month.

Over the years, shotcrete services had been rendered in every market sector Buesing serves, highlighting the diverse application of shotcrete in both temporary and permanent project developments and construction.

NICHE

As an industry leader, Buesing have been providing shotcrete services for years within two primary niche markets; shotcrete for shoring, and permanent below-grade walls.

Buesing provides shotcrete facing for its own self-performed earth retention (shoring) services on a weekly basis since 2009, exceeding 200 completed projects and a total of 2,500,000 ft^2 (230,000 m^2).

In most cases in the Arizona market, these shotcrete facing projects are designed to be temporary. However, when the project requires, the tolerancing and finish is completed to meet required expectations for waterproofing systems normally installed between the shoring system and permanent wall.

Buesing also provides value-added scopes of work such as structural shotcrete or finish walls (permanent). This is often the next logical step, shot against the earth retention (shoring) system Buesing just installed at the perimeter wall alignment (wall line) for below-grade structures.

In about half these installations, an integral waterproofing product was included as a value engineering alternative to conventional waterproofing as a cost and time savings. This integral waterproofing alternative consists of commercial-grade crystalline products with the manufacturer's full engineering support and warranty services.

UNIQUE WORK—RADIUS WALLS

Buesing Corp has performed shotcrete involving radius walls on three projects, and one of these projects was the Phoenix Children's Hospital (PCH) original construction (Phase 1). Phase 1 of PCH was construction in 2010 through 2011. The PCH building as seen above ground includes the radius wall, top to bottom, including the basement level that was constructed of a shored and permanent radius wall below ground.

The expansion project that extended the radius wall (Phase 2) was completed between 2017 and 2018. Phase 2 of PCH was an expansion immediately adjacent to the first phase, and the basement elevations and radius wall was extended into its proposed building footprint.

On any project and including PCH, the straight wall process of excavation, temporary shoring shotcrete facing on tolerance, and permanent finish walls on tolerance required planning, experience, and skill. Buesing's crews exemplify these attributes on every job, which are embodied from the project manager, foreman, nozzleman, and finishers. A radius wall project admittedly adds a unique complexity to this process.

Whereas the individual steps to complete a radius soil nail/shoring wall facing, and then a permanent structural wall are similar to that of a straight wall, extra care in the planning and setup (batter boards, piano guiding wire) is certainly a must. The paramount aspect of the process to ensure successful radius wall construction is a blend of skill and some degree of "art" to visualize what each crew member is building and implement the minute details working towards that end.

Buesing does not have a long resume of radius walls as the projects are far and few in between, however, the company will not hesitate to perform the next radius wall because Buesing has what it takes to be successful doing them.

Buesing will also provide its shotcrete services to perform project applications such as below-grade garage excavations/walls ranging from 5 to 75 ft (2 to 23 m) deep, new and repair of trapezoid ditch and channel lining, slope or embankment stabilization, and pipe backfill in lieu of slurry.

SAFETY

Buesing makes safety a priority across all its services and project work, including shotcrete. The company values the importance of proper personal protection equipment, hot weather considerations, and training. Given the diversity of services that Buesing provides and market sectors it serves, its Experience Modification Rating (EMR) was 0.61, 0.61, and 0.78 the last 3 years.

BUESING CORP

3045 S. 7th Street, Phoenix, AZ 85040
Phone: 602.233.3339
Website: https://buesingcorp.com

Fig. 3: Soil nail facing at Phoenix Children's Hospital on radius walls

Fig. 4: Buesing Nozzleman

Fig. 5: Long float

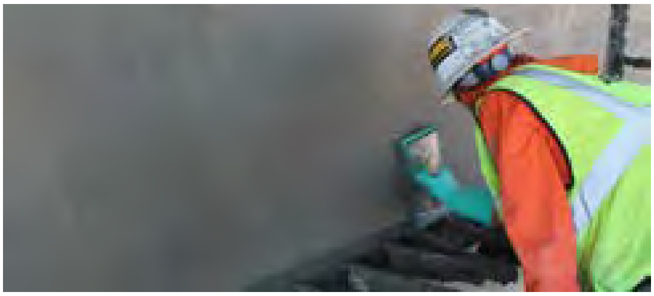

Fig. 6: Rubber float

Fig. 7: Broom drag finish

CROM®

PRESTRESSED CONCRETE TANKS | COATINGS AND RESTORATIONS

In 1953, J.M. Crom Sr., and three associates—Ted Crom, Jack Crom Jr., and Frank Bertie—established CROM® in Gainesville, FL, with a sole purpose of refining the design and construction techniques of composite tanks. Since then, subsequent leadership and team members have continued building the CROM name throughout the national and international markets as a trusted and experienced resource in the water and wastewater sector. While CROM tanks can be found worldwide, CROM predominantly drives its operations throughout the Southeast United States, including Florida, Georgia, Alabama, Mississippi, Louisiana, South Carolina, North Carolina, Virginia, Kentucky, and Tennessee. Due to high demand, CROM has expanded their local presence with regional offices in Chattanooga, TN; Raleigh, NC; West Palm Beach, FL; and Fort Myers, FL.

Fig. 1: CROM archives: photo of shooting a floor

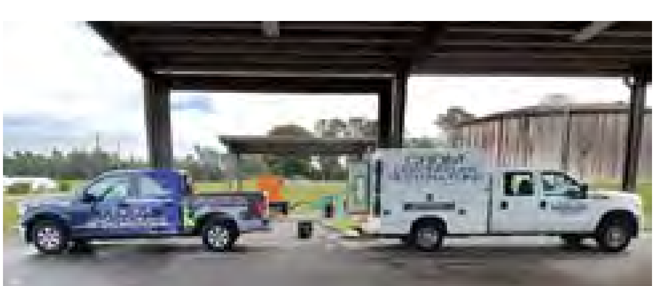

Fig. 2: CCR trucks in 2019

CROM TODAY

Due to the specialized construction methods and equipment developed for prestressed concrete tanks, CROM's distinctive skills were well suited to expand into inspection, repair, and modification of aging infrastructure with a second division, CROM Coatings and Restorations (CCR). CCR consists of highly trained and dedicated infrastructure repair specialists including a team of technicians, estimators, and project managers.

The CROM team of tank builders and repair specialists fully collaborate to provide customized solutions for proper design, specifications, and execution of new design-build projects and repair of existing infrastructure. The CROM field crews are supported by multiple departments including engineering, safety and training, fabricators, mechanics, and

Fig. 3(a) and (b): CROM prestressed concrete tanks expeditors. In addition, we have created strategic partnerships with industry professionals, material manufacturers, and suppliers to assist in properly assessing and recommending proper procedures and materials to ensure the quality, reliability, and longevity engineers and owners value from their successful history with CROM prestressed concrete tanks.

CERTIFICATION-BASED EXPERIENCE

CROM is an active, long-time corporate member of ASA and ACI, and currently has 24 ACI-certified shotcrete nozzlemen. The company hosts certification and training sessions every 2 years. CROM's shotcrete training program actively recruits new employees and encourages those interested to become certified in this highly specialized field of wet- and dry-mix shotcrete applications. CROM also specializes in hydrodemolition, chemical injection of both urethanes and structural epoxies, fiberglass and carbon fiber strengthening for retrofit and modifications, post-tensioning with high tensile strength strand, specialized repair mortars, and high-performance coating applications backed by certifications from NACE, SSPC, ICRI, and individual product manufacturers.

FEATURED PROJECT

An ongoing rehabilitation project at Mocassin Bend Wastewater Treatment Plant in Chattanooga, TN, has CCR working in two phases. Phase One was to refurbish detritors one through three. The detritor interiors had areas of severe deterioration from hydrogen sulfide exposure. Once the loose materials were removed, a combination of a 2 in. (50 mm) Carousel pump for repair mortars (Tnemec 217, 218) and WIWAH pump for protective coatings (Tnemec 436, 435) was applied.

Fig. 4(a) and (b): CROM nozzlemen certification testing

CROM LLC

250 SW 36th Terrace, Gainesville, FL 32607
Phone: 352.372.3436
Website: www.cromcorp.com
E-mail: info@cromcorp.com

The concrete repairs ranged from 1/4 to 3 in. (6 to 75 mm) in depth. Application of the repair mortars were applied under the direction of an ACI-certified shotcrete nozzleman.

The second phase is underway and includes the rehabilitation of sludge thickeners one through five. After years of deterioration, the interior walls have significantly eroded from the constant flow of wastewater. Repairs in this phase included removing all loose materials and applying approximately 3/8 in. (9 mm) of silica fume, fiber-reinforced repair mortar (Sika 224), returning the walls to their original thickness using 2 in. Carousel pump.

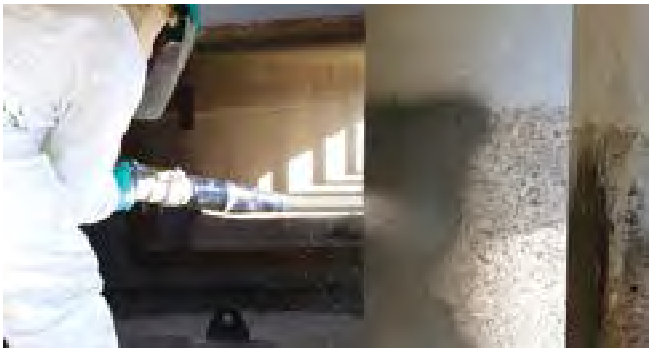
Fig. 5: Mocassin Bend Wastewater Treatment Plant phase one

Fig. 6(a) and (b): Mocassin Bend Wastewater Treatment Plant phase two

KING CONSTRUCTION PRODUCTS GROUP ANNOUNCES NEW RS CONCRETE PRODUCTS

King Packaged Materials Company introduced three new products, including KING RS-S10, KING RS-S10 UG, and KING RS-S10 SCC—all powered by Rapid Set® technology. KING RS-S10 and KING RS-S10 SCC can reach a compressive strength of 3625 psi (25 MPa) in 3 hours, while KING RS-S10 UG can reach a compressive strength of 5075 psi (35 MPa) in 3 hours, under the proper conditions. KING continually investigates different approaches to obtain the minimum required compressive strength as quickly as possible. Working with Rapid Set cement technology from CTS, KING has developed a line of concrete repair products to bring early-age compressive strength gain to another level.

KING RS-S10 and KING RS-S10 SCC are a highly durable, high-performance, rapid-hardening, latex-modified, prepackaged concrete material. These products are a preblended, cementitious concrete repair and construction material. Both contain a redispersible polymer, 3/8 in. (10 mm) stone and other carefully selected components. These products were designed for concrete repair applications requiring return-to-service within hours. KING RS-S10 is ideal for partial- and full-depth rehabilitation of concrete slabs, parking garages, balconies, or bridge decks. KING RS-S10 SCC is ideal for partial-depth, formed repairs of concrete beams, columns, soffits, and shear walls in bridges, parking garages, or other concrete structures.

KING RS-S10 UG is a prepackaged, rapid-hardening concrete mixture designed for underground construction. This product is a preblended concrete mixture and contains fine and coarse aggregates, as well as other carefully selected components. KING RS-S10 UG is ideal for construction of concrete floor slabs, walls, grizzlies, door frames, and other underground concrete services.

For more information, call 905.639.2993 or visit **www.kpmindustries.com**.

PUTZMEISTER MACHINE TELEMATICS

Putzmeister telemetry allows users to work more economically and efficiently. Beginning in 2020, Putzmeister America, Inc. (Putzmeister) began offering it standard on all truck-mounted concrete boom pumps. In the Machine Cockpit interface, all relevant information for the machine can be called up in real time. Companies can keep a complete overview of their fleet and assets. It provides warning messages for critical states, such as hydraulic temperatures, pump output, and location, which enable remote diagnosis of machine faults and can provide automatic maintenance planning messaging to reduce costly downtimes. Real-time information and the overview of all relevant operating figures, such as output, machine usage, and fuel consumption, can improve planning and productivity.

As of February 2020, this module will be included in the basic equipment. Older machines, though, can also be retrofitted without a problem.

Telemetry services will be offered to Putzmeister America customers for the length of the warranty of their boom pump, including the purchase of an extended warranty. Customers can also purchase aftermarket telemetry units for installation on existing fleet, which will also include Machine Cockpit interface and cellular service. The customer will be able to choose to receive data outside of the Machine Cockpit portal via the following methods:

- API via cloud interface for a minimal fee per machine;
- Direct connection to telemetry hardware on board (will be available with new telemetry box late 2020); and
- If customers want data translated, there will be an IP fee.

For more information, visit **www.putzmeister.com**.

EUCLID CHEMICAL EUCOWELD 2.0

Euclid Chemical Eucoweld 2.0 is a liquid latex bonding agent for use with cement-based repair mortars and concrete. Eucoweld 2.0 is a unique, non-EVA-based latex that uses reactive chemistry for bonding. This bonding agent features benefits that provide:

- Excellent bond strengths;
- Easy to use—applied to substrates straight from the container, with no dilution or mixing;
- Can be used "wet on wet"—install repair materials immediately after Eucoweld 2.0 application;
- May be allowed to dry—apply Eucoweld 2.0 up to 7 days prior to repair material installation;
- Eucoweld 2.0 latex technology is not moisture sensitive after application; and
- Very low VOC content.

For more information, call 800.321.7628 or visit **www.euclidchemical.com**.

QUIKRETE TROWEL GRADE RE-CAP AND RAPID ROAD REPAIR – CA

QUIKRETE®, manufacturer of preblended commercial-grade cement and concrete products, strengthened its repair portfolio with the additions of its Trowel Grade Re-Cap, Rapid Road Repair – CA (Calcium Aluminate), and an updated version of FastSet™ Repair Mortar.

QUIKRETE Trowel Grade Re-Cap

A special blend of portland cement, sand, polymers, and other proprietary additives, Trowel Grade Re-Cap is a versatile shrinkage-compensated material ideal for repairing spalled, cracked, or pitted concrete surfaces from 1/16 to 1/2 in. (2 to 13 mm). It has a bond strength four times greater than the concrete itself. That means a concrete substrate will fracture or crack before its bond with Trowel Grade Re-Cap. With 30 minutes of working time, one 20 lb (9 kg) bucket will cover approximately 5 ft^2 (0.5 m^2) at 3/8 in. (10 mm) thick and up to 15 ft^2 (1.4 m^2) at 1/8 in. (3 mm) thick. Trowel Grade Re-Cap has a walk-on time of 3 hours and drive-on time of 24 hours.

QUIKRETE Rapid Road Repair – CA

Rapid Road Repair can be used for rehabilitating bridge decks, highways, runways, parking garages, parking lots, driveways, and other industrial concrete surfaces. Rapid Road Repair – CA is a new calcium aluminate cement-based formulation that also features fast-setting cements and alkali-resistant (AR) glass fibers. This new repair material provides contractors up to 30 minutes working time, greater high-early compressive strength, and increased tensile strength. Regardless of the jobsite environment or conditions, permanent structural partial-depth repairs up to 2 in. (50 mm) can be completed quickly. Rapid Road Repair – CA is available in 50 lb (23 kg) bags and reaches 3000 psi (21 MPa) in 90 minutes, 4500 psi (31 MPa) in 3 hours, and 8000 psi (55 MPa) in 28 days. For full-depth repairs greater than 2 in., a version of Rapid Road Repair – CA extended with gravel or stone is available in 80 lb (36 kg) bags.

QUIKRETE FastSet Repair Mortar

FastSet Repair Mortar was formulated to make structural repairs to any concrete, masonry, or stucco surface. The improved adhesion and reduced shrinkage make FastSet Repair Mortar even more ideal for vertical and overhead repairs. With 20 to 30 minutes working time and its unique properties allow for the sculpting of the material during placement, FastSet Repair Mortar can be used on damaged curbs, steps, prestressed panels, loading docks, retaining walls, and sewers.

For more information, call 800.282.5828 or visit **www.QUIKRETE.com**.

ACI ANNOUNCES NEW POSITION STATEMENTS

The American Concrete Institute (ACI) recently published its first six position statements. These position statements support policy positions and state, federal, and international programs, rules, and regulations.

The Institute's position statements are focused on advocacy efforts related to code development and adoption. Current positions statements include:

- Current Code and Standard Adoption—Encourage the adoption and/or use of current building codes and standards;
- Adoption of ACI Documents Without Modifications—Encourage the adoption and use of ACI products, including but not limited to codes and standards without modification;
- Acceptance of ACI Certification Programs—Support acceptance of sampling, testing, inspection, and installation of concrete and related products and materials; encourage the use of certification programs developed and administered by professional societies in lieu of programs developed and administered by other entities; and support mandates or otherwise place preference on accreditation of individuals and entities engaged in providing services related to concrete and concrete products;
- Concrete Knowledge—Support research, technological advancements, and dissemination of concrete technology; and channel through, directed to, or otherwise engage ACI and/or the ACI Foundation;
- Enhanced Resilience—Encourage or establish criteria related to enhancing the resiliency of the built environment; and where appropriate, engage ACI and/or the ACI Foundation to facilitate programs and activities related to the role of concrete technology in achieving enhanced resiliency; and
- Sustainability—Encourage or establish criteria related to enhancing the sustainability of the built environment; and where appropriate, engage ACI and/or the ACI Foundation to facilitate programs and activities related the role of concrete technology in achieving enhanced sustainability.

"These position statements provide a vehicle for the American Concrete Institute to advocate on issues of code development and code adoption in support of our expanded mission," states Steve Szoke, ACI Advocacy Engineer.

"The Institute has used and will continue to use these statements to align ACI efforts with other industry organizations to more effectively influence programs, policies, rules, and regulations related to concrete and concrete technology," continues ACI Advocacy Engineer, Kerry Sutton.

For more information, call 248.848.3800 or visit **concrete.org/positions**.

SHOTCRETE CALENDAR

MARCH 10-14, 2020	**CONEXPO – CON/AGG 2020** Las Vegas Convention Center | Las Vegas, NV **www.conexpoconagg.com**
MARCH 23-25, 2020	**2020 ICRI Spring Convention** JW Marriott Parq Vancouver | Vancouver, BC, Canada **www.icri.org**
MARCH 28, 2020	**ASA Spring 2020 Committee Meetings** Hyatt Regency O'Hare | Rosemont/Chicago, IL **www.shotcrete.org**
MARCH 29 – APRIL 2, 2020	**The ACI Concrete Convention – Spring 2020** Theme: "Concrete in the Windy City" Hyatt Regency O'Hare | Rosemont/Chicago, IL **www.aciconvention.org**
JUNE 7-10, 2020	**North American Tunneling Conference (NAT) 2020** Nashville, TN **www.natconference.com**
JUNE 28 – JULY 1, 2020	**ASTM International Committee C09, Concrete and Concrete Aggregates** Boston Marriott Copley Place | Boston, MA **www.astm.org**
SEPTEMBER 28-30, 2020	**MINExpo International** Las Vegas, NV **www.minexpo.com**
OCTOBER 5-7, 2020	**2020 ICRI Fall Convention** Minneapolis Marriott City Center | Minneapolis, MN **www.icri.org**
OCTOBER 24, 2020	**ASA Fall 2020 Committee Meetings** Raleigh Convention Center & Raleigh Marriott | Raleigh, NC **www.shotcrete.org**
OCTOBER 25-29, 2020	**The ACI Concrete Convention – Fall 2020** Theme: "Carolina Style Concrete" Raleigh Convention Center & Raleigh Marriott | Raleigh, NC **www.aciconvention.org**
OCTOBER 29-30, 2020	**Chicago Build 2020** McCormick Place | Chicago, IL **www.chicagobuildexpo.com**
DECEMBER 6-9, 2020	**ASTM International Committee C09, Concrete and Concrete Aggregates** Renaissance Orlando at SeaWorld | Orlando, FL **www.astm.org**
FEBRUARY 21-23, 2021	**2021 ASA Shotcrete Convention & Technology Conference** Sonesta Resort | Hilton Head, SC **www.shotcrete.org**
MORE INFORMATION	To see a full list with active links to each event, visit www.shotcrete.org/calendar.

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