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VOLUME 20, NUMBER 2 • SPRING 2018

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FEATURES

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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: Shotcrete restoration work on Outstanding Project, Honorable Mention, the Albertus L. Meyers Bridge in Allentown, PA. Photo by Sam Interrante, Lancaster, PA.

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Twenty Years and Growing Strong

By Lihe (John) Zhang

The American Shotcrete Association (ASA) will be 20 years old this year. To celebrate the anniversary, we decided to a host our first convention at the upscale Silverado Resort and Spa in the Napa Valley wine country of California. The convention included the kickoff full-day Contractor Qualification Seminar on March 11, ASA and ACI committee meetings on March 12, and our first Shotcrete Technology Conference on March 13, followed by the Annual Outstanding Shotcrete Projects Awards Banquet. As this was our first convention, there was a lot of planning (and worrying) about how to provide the best experience for our attendees. Fortunately, all the planning by our task groups and staff, along with support from the venue, resulted in a hugely successful event. Here are some of the highlights:

- Over 135 people attended, with a majority of 3-day and many 1-day registrants.
- Attendees included contractors, engineers, owners, educators, and suppliers from all different market areas for shotcrete.
- The Technology Conference Sessions at our conference were very well received. A total of 18 sessions in three parallel tracks covered a diverse spectrum of shotcrete topics. All sessions were well attended and had great audience involvement.
- Many new faces showed up during the ASA convention. Attendees came from California; New York; Florida; New Brunswick, Canada; and many other places in North America and internationally, including people from Peru, Switzerland, and South Korea.
- We had 16 exhibitors who enjoyed the opportunity to sponsor the event and display their company's product among a group focused on the shotcrete market in an exhibit area that provided great visibility to all the attendees.
- The wine country of Napa, CA, is world famous for its wine cave construction with shotcrete. The ASA banquet was held at historic Inglenook Winery that is over 120 years old. The wine cave there was constructed with a shotcrete lining, which guests could tour during the reception.

Apart from these highlights, the ASA convention attracted a record-high sponsorship. ASA and I thank those who sponsored and attended the convention.

The ASA Board of Directors offers special thanks to our two full-time staff members Charles Hanskat and Alice McComas, who devoted so much of their time and effort to make this convention so successful. When we decided to investigate the possibility of hosting our first convention at our Board meeting in Farmington Hills, MI, in spring of 2017, we never imagined the work that would go into the planning and execution. We set an extremely ambitious goal, and through careful planning and execution, the result was overwhelmingly positive.

ASA was established in 1998, by a group of shotcrete experts including George Yoggy, Pete Tatnall, Rusty Morgan, Lars Balck, Meryl Isaack, and many others to promote quality shotcrete. Shortly after its establishment, ASA worked through ACI to establish the ACI Shotcrete Nozzlemen Certification program. This program has grown dramatically, with over 1700 nozzlemen currently certified. This effort by ASA and our members has definitely changed the shotcrete industry for the better.

After 20 years, ASA has grown into an association of over 850 members. ASA is the international sponsoring group for the ACI Shotcrete Nozzlemen Certification program and we work to constantly improve the quality and consistency of the program with our experienced team of examiners and staff.

During the past 5 years, ASA has grown in a faster and healthier way. We have produced a strategic plan to help focus our Association efforts and, after experiencing much progress with our activities, refreshed it in 2017. Under the strategic plan, ASA has identified action items for every committee, reinforcing our overall strategic goals. Updates to these action items are often reported in the various Committee Chair Memos included in every issue of *Shotcrete* magazine.

The shotcrete industry is experiencing significant growth and acceptance among designers, owners, and contractors. ASA has significantly contributed to this growth. Our outreach, educational programs, and activities will continue to build the shotcrete market. As an Association, our life blood is our active member involvement. I'm honored to serve as President of ASA this year, and look forward to working with the Executive Committee, Board of Directors, Committee Chairs, Committee Members, and ASA staff. I hope to see more of you, who may not yet be members, join with us to lead our industry forward.

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Membership Committee

By Cathy Burkert

ASA celebrates its 20th anniversary this year! Established in 1998, the Association started with only three members and has now grown to 239 Corporate Members. In combination with our other membership categories, ASA serves a membership of over 850! In 2017 alone, ASA membership grew at a rate of 12% over 2016, led by the significant increase in nozzlemen certification and recognition of ASA's outreach and leadership in the shotcrete industry. ASA membership includes contractors, engineers, architects, equipment suppliers, material suppliers, owners, consultants, educators, students, and shotcrete crew members, all sharing the interest of advancing the use of shotcrete.

Our membership benefits from the substantial growth in programs and resources afforded by the Association. Corporate members have enhanced opportunities to promote their business to the shotcrete industry in increased visibility to the global marketplace through ASA's Buyers Guide, press release announcements in *Shotcrete* magazine, Corporate Member Profiles, and online Bid Proposal requests. ASA actively promotes the quality and durability of shotcrete to DOTs, engineers, architects, and other specifiers through our Onsite 1-Hour Seminars and the new full-day Shotcrete Inspector Education seminar created to support ACI's upcoming Shotcrete Inspector Certification program. ASA's full-time technical support has also been an invaluable resource to our members, project owners, engineers, architects, owners, and others who are specifying shotcrete or require technical assistance to resolve concerns. Additionally, the Association's quarterly magazine, *Shotcrete*, is widely acknowledged as the most authoritative and useful publication on shotcrete for the entire industry. As the magazine has grown in content and scope, it continues to provide a wealth of valuable tips, techniques, and cutting-edge resources for the shotcrete industry.

One of the biggest benefits ASA offers is opportunity.

- The opportunity to meet people worldwide who share the same passion for shotcrete.
- The opportunity to network with others in the industry and access all the resources ASA has to offer.
- The opportunity to market your business to those that understand the needs in the shotcrete industry.
- The opportunity to reach out to those who are curious to understand the shotcrete process and how it may be beneficial on a specific project.
- The opportunity to pick up the phone and call a member when you have a question on your project.

Our ASA members are some of the most knowledgeable people in the world about shotcrete and can be a wealth of information. This was adeptly illustrated at our First ASA Shotcrete Convention and Technology Conference, held in Napa, CA, where new and "old" faces connected over committee meetings, meals, exhibits, and 18 Technology Conference sessions sharply focused on the shotcrete industry! It was a truly magnificent celebration for ASA's 20th Anniversary!

Yet with all these additions to the Association, ASA membership dues have remained the same for the last 20 years. ASA has become known in the concrete design and construction industry as THE resource for factual and relevant knowledge about shotcrete. To continue the great gains we've made in advancing our programs and resources, the Association recognizes the need to increase our financial commitment. This led to our Board approving the first membership dues increase since our founding

20 years ago. You can expect to see these changes introduced later this year.

We will still have the same membership categories: Corporate, Corporate Additional, Individual, Retired, Nozzlemen, Student, and Public Authority. However, we are also introducing a new Sustaining membership category. This category allows a Sustaining Corporate Member to designate up to three additional corporate members for their company. The Corporate Additional memberships allow for additional members of a company to become actively involved in our committee work. They receive voting rights on committees they join and for the annual election of ASA Officers and Directors. Sustaining members will also be highlighted on the ASA website, in the online Buyers Guide, and acknowledged at ASA-sponsored events such as the Awards Banquets and future Conventions. Corporate members can expect to see communication in their membership renewals, offering them the opportunity to upgrade to a Sustaining Corporate membership. Sustaining membership exemplifies their company's commitment to and support of our Association's mission by selecting this membership category.

ASA, as an Association, in our short 20 years has had a profound impact on acceptance and promotion of quality shotcrete in a wide variety of concrete construction. Our strategic plan has a vision to have shotcrete accepted as an equal or superior to form-and-pour concrete construction. Working together as members of an Association, with a common vision and goal, we achieve much higher recognition and acceptance for shotcrete than any single individual or company can achieve alone. Our members working together, supporting our Association's programs and staff, are the best way to move our industry forward with a unified voice. If you aren't now a member of ASA, please consider joining us and lending your support to making shotcrete the quality and durable concrete placement method it deserves to be.

The Mission of ASA: "ASA provides knowledge resources, qualification, certification, education, and leadership to increase the acceptance, quality, and safe practices of the shotcrete process."

ASA plans to increase annual membership rates over the next 2 years. The changes will be as follows:

- **In 2018, rates will increase to: Sustaining $1125; Corporate $875; Individual $300; and Retired $75.**
- **In 2020, rates will be: Sustaining $1250; Corporate $1000; Individual $350; and Retired $100.**

Corporate Additional and Nozzlemen member rates will remain the same at $100 and $50, respectively. Student and Public Authority memberships continue to be complimentary.

ASA—Out of our Teenage Years, But Still Growing

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

First, I note with sadness that one of our founding members, George Yoggy, passed away on March 27. Though unfortunately I only met George once at an American Concrete Institute (ACI) meeting in Washington, DC, I have had numerous correspondence with George, primarily with input on my past articles or responses to technical inquiries. His input was always insightful, accurate, and gave me a valuable perspective. It is clear in talking with those who have worked directly with George that his knowledge and enthusiasm for shotcrete had a huge impact on advancing acceptance of shotcrete. George was a problem solver and found innovative ways to use and improve shotcrete equipment and placement. He was also giving of himself and never hesitated to share his knowledge and decades of experience with those he met.

Many of our ASA members worked closely with George over the years, and to several, he was the ultimate mentor. George was also very active in the underground shotcrete world, a member of the Moles, and Past President of the American Underground Construction Association (now UCA). He was a devoted husband, father, and grandfather, putting his family and faith as the top priorities in his life. He will be missed by family, by friends, by co-workers, by ASA members past and present, and by our shotcrete industry. We've printed a short memorial to George in the Association News section, with some remembrances from members who worked closely with him.

It's sad that as our Association matures and grows, we lose those insightful individuals who saw the need for an association like ASA back in 1998. We truly stand on the shoulders of giants like George Yoggy.

OUR FIRST SHOTCRETE CONVENTION AND TECHNICAL CONFERENCE

Several of our other columns in this issue of *Shotcrete* magazine recap details of the first ASA Shotcrete Convention and Technology Conference. In brief, it ran very smoothly, provided great opportunities to network with the key players in the shotcrete industry, and based on attendee feedback, was enjoyed by all. Planning the various activities, the sessions, the meals, the awards, the banquet, interacting with the Silverado Resort and Spa and Inglenook Winery venues, promoting the convention, coordinating sponsors and exhibits, gathering registrations, and finally, once on site, executing everything so smoothly took a massive amount of behind the scenes work. All our ASA staff, including Alice McComas and Beth Hinman, spent long hours pulling together all the multitude of items needed for the convention. We also had exemplary graphics support from ACI's Publishing Services department, especially Susan Esper, who somehow could put together a perfect image or layout for an ad, brochure, or program with little notice.

I, along with all our attendees, are especially indebted to Alice McComas, our Senior Program Coordinator, for her commitment to make this, our very first full-fledged convention, a success. Doing anything of this scale for the first time is never easy, yet Alice cheerfully accepted the challenge and with her attention to detail and countless hours of time in planning and coordinating (and worrying) made the event a huge success—an event that all who attended agree wildly exceeded our expectations. My sincere and heartfelt thanks to Alice for her commitment and service to ASA.

THE NEXT DECADE

Having three sons, two now in their thirties and another just turning twenty, I can reflect on ASA as we, too, exit the "teenage" years. The teenage years of my sons were times of often turbulent growth, exposure and understanding of the broader world around us, and learning from experience by interacting with the world outside the family and the small classroom. My sons have all, towards the end of their teenage years, developed their own "identity," establishing what they want to look like among their peers and how they want to be involved in shaping the world around them. In many ways, ASA is in a similar stage of our growth.

The last seven "teenage" years have seen us within ASA focus on our mission and set a strategic plan to help achieve significantly enhanced goals. We've been busy growing and maturing (fortunately without the hormones). We've improved the consistency and quality of the Shotcrete Nozzleman Education and ACI Certification and brought nozzleman certifications to record levels. We've added major programs like the Shotcrete Inspector Education and Shotcrete Contractor Qualification to improve the knowledge and quality in our industry. We've greatly expanded our outreach to specifiers across North America, as well as introduced educators and students to shotcrete to let them learn about its applications, quality, and durability. We've worked with ACI, ASTM, ICRI, and AREMA technical committees to update and properly include shotcrete placement in their documents. We've developed and distributed position statements to raise the quality of shotcrete construction in key markets like the pool industry.

Yes, we've had our share of controversy, heated discussions, and sometimes challenges in gaining consensus (as those who have or had teenagers may have experienced). But these are good things that in the end help us to be more representative of our members and solidify our "identity." As we celebrate our 20th Anniversary, we are a stronger association and a more respected voice in the concrete construction industry. You can walk the halls or attend committee meetings at an ACI or ICRI convention and hear attendees talking about shotcrete. We are getting numerous requests to talk about shotcrete to state DOTs, government agencies, and regional engineering conferences. This wasn't true 7 years ago. This demand shows how we have matured in the eyes of the concrete industry. Thanks to all our current and past committee members and officers who have led ASA to allow us to survive, and in fact thrive and mature as an association through our first 20 years. Our maturity and strength of purpose helps reinforce our place as an association whose members and mission are an important facet of concrete construction today and by all accounts an increasingly valuable contributor in the decades ahead.

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2017-2018 Awardee

ASA is pleased to announce that the 2017-2018 ASA Graduate Student Scholarship has been awarded to Émile Blouin-Dallaire. The following is a brief biography and description of his research.

***Émile Blouin-Dallaire**, Jr. Ing., holds a bachelor's degree in civil engineering from Laval University, Quebec City, QC, Canada, where he is currently completing his master's degree in the same field of study. His ongoing research project aims to optimize curing techniques and their impacts on shotcrete shrinkage and cracking. This project is part of the effort to reduce the cracking potential of shotcrete repairs and to improve their durability. He is working on one of several projects of the Collaborative Research and Development grant supported by King Shotcrete Solutions and the Canadian Natural Sciences and Engineering Research Council.*

MASTER'S RESEARCH PROJECT
Curing Techniques and Their Impacts on Shotcrete Shrinkage and Cracking

Shotcrete placement pneumatically accelerates concrete onto a surface where the high-velocity impact of the paste and aggregates achieves sufficient compaction on the receiving surface.[1] Shotcrete is a concrete application method frequently used in the concrete repair industry as well as the mining/ground support field.[2] One of the most important parameters to consider is the compatibility of the deformations within the concrete matrix.[3-7] Because shotcrete can cover large surface areas (for example, a wall or abutment repair) without the use of formwork, the results are a large surface of fresh concrete exposed to the environment. With insufficient protection, it will quickly lead to differential shrinkage between the concrete substrate through the relatively thin shotcrete layer. If not cured and protected properly, this shrinkage will inevitably lead to cracking.

One of the main objectives of this project is to give the industry a greater understanding of methods for reducing the cracking potential of shotcrete repairs and subsequently enhancing their durability. Knowledge needs to be improved on the methods to perform adequate protection during the curing of shotcrete repairs. Furthermore, the shotcrete industry has seen a considerable increase over the years in durability and aesthetic quality requirements. This project is part of the effort to reduce the cracking potential of shotcrete repairs, and to in turn improve their durability. Such improvements must include enhanced curing and protection practices to fully take advantage of the shotcrete process.

Curing techniques are an area that needs serious research. Indeed, current practices in North America go from minimal protection for only a few hours to extensive curing and protection for up to 14 days. As expected, the success level of these approaches is quite variable, as are the related costs and constraints on the jobsite. Much research remains to be done and explored in curing to determine what really works, and at what cost. The obvious question, and by extension the objective of the project, is to find out how much is enough. An investigation needs to be conducted to identify curing methods that minimize effects of shrinkage on shotcrete. Many environmental factors can influence the cure, including items such as temperature and humidity in addition to the methods and products used.

To achieve the previously defined objectives, the project's scientific objectives are to:

- Develop a reliable early shrinkage measurement method that allows the application of curing and sealing compounds to exposed surfaces without compromising shrinkage measures;
- Independently assess the impacts of external curing techniques on shrinkage of shotcrete;

- Explore internal curing techniques and assess their impact on shrinkage of shotcrete; and
- Define various complete curing scenarios and quantify their effects on shrinkage of shotcrete.

Many studies have been conducted to assess the influence of curing on shotcrete mechanical properties, but there are many unanswered questions about curing and protection practices as applied directly to shotcrete placement. The lack of comprehensive research on this subject leaves room for a lot of interpretation (and misconceptions) when trying to determine what really works.

Finally, this master's project seeks sustainability of better cured and protected shotcrete at both the environmental and economic levels. Indeed, this research ultimately aims to limit the environmental impacts of our infrastructure by increasing their lifetime. This project is also part of the effort to extend the useful life of structures because the main objective is to enhance shotcrete repair's resistance to cracking and increase their durability. Also, shotcrete greatly reduces the quantities of materials used and disposed of on a repair project. Moreover, maintenance is reduced by increasing the durability, further reducing CO_2 emissions. For the economic aspect, it goes without saying that producing more durable repairs bring significant economic benefits by increasing the useful life of the structures as well as reducing the frequency of maintenance.

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2017 Outstanding International Project

Regionally Symbolic Tunnel Portals at Expressway

By Kyong-Ku Yun, Yong-Gon Kim, and Sung-Yong Choi

Since the construction of the first expressway in the 1970s, the total length of expressways in Korea has increased to 2757 miles (4437 km), of which 542 miles (872 km) include 1055 tunnels. These tunnels are characterized by their portals. Currently, the local inhabitants demand a much higher standard of living. When considering improvement of transportation quality, environmental protection and ecological conservation aesthetics of the tunnel portal must also be provided.

The tunnel portals were constructed using shotcrete technology with carving for texturing and acid staining for coloring, creating an artificial rock (Fig. 1). These tunnel portals were designed with input of the local inhabitants, who wanted the portals to represent their regional characteristics. The inhabitants were very satisfied with the final work, as they appreciated each portal was a beautiful and symbolic representation of their community. All the various portal designs were made possible with shotcrete's inherent ability to adapt to curved and irregular surfaces, allow for different surface finishes, provide excellent physical properties, and as a fast and economical process.

Fig. 1: Overview of symbolic tunnel portal

Fig. 2: Concept of cellular sprayed concrete

CELLULAR SPRAYED CONCRETE

A new adaptation of the shotcrete process "cellular sprayed concrete" was developed for the project. Cellular sprayed concrete is produced by introducing cellular and mineral admixtures while remixing and dispersing the mineral admixture in ordinary ready mixed concrete at a jobsite. Higher strength and durability are produced by the addition of the mineral admixtures. Production cost and construction time can be reduced because the high-performance cellular sprayed shotcrete is produced by adding silica fume in the ready mixed concrete on the jobsite without the need for production, transportation, and storage, which are required when special blended cement is used.

The processes of cellular sprayed concrete are as follows:

1. Bring an ordinary ready mixed concrete having a low slump in a truck to a jobsite;
2. Add a preformed cellular material with 20 to 30% by volume into a truck, then the stiff concrete would become more fluid with a very high slump;
3. Add silica fume, and remix to disperse it. The silica fume could be easily dispersed in the high-slump concrete; however, the concrete contains lots of air inside so it requires more mixing; and
4. Supply the cellular concrete to a mobile concrete pump with a boom that has the nozzle at the end and spray the cellular concrete with a high air flow. The high-velocity impact disperses much of the air in the concrete, thus producing a low-slump, high-performance concrete in place. Figure 2 illustrates the concept of cellular sprayed concrete.

SHOTCRETE MATERIALS

The cellular sprayed concrete was developed to be cost-effective. Table 1 shows an ordinary and high-performance concrete mixtures. The slumps were measured to be 3 in. (80 mm) in the ordinary ready mixed concrete, 7.5 in. (190 mm) after adding the cellular material and silica fume,

Table 1: Concrete Mixture Designs

Type	W/B	S/a (%)	Unit content (kg/m³)						
			Water	Cement	S.F.	Sand	Gravel	AE	Cellular
OPC	0.42	65	164	390	—	1146	619	3.9	—
HPC	0.43	65	164	390	30	1146	619	3.9	220

and then 0.4 in. (10 mm) after spraying. The final targeted total air content was between 3 to 6% after spraying.

CONSTRUCTION METHOD

Cellular sprayed concrete reduced construction time because a very high volume of concrete could be placed using standard ready mixed concrete and a concrete pump with a remotely manipulated boom for the nozzle. The additional equipment required is a foam generator and an air compressor. It is a very efficient production system for high-performance concrete because not too much specialized equipment is required. This method enables top-down or bottom-up concrete construction of the tunnel portal without formwork, as shown in Fig. 3.

Spraying (Fig. 4), carving (Fig. 5), and coloring natural rock patterns is an eco-friendly technology that harmonizes with the surrounding landscape. This method was adopted to the tunnel portals. It was designed to meet the demands of the local community, and represent their regional symbolic characteristics in the final concrete surfaces. The towns were very happy with the beautiful and symbolic appearance of their own tunnel portals.

TEST RESULTS

The high-performance shotcrete required strength and durability because it is exposed to weather on the face of the tunnel portals. Three specimens of the shotcrete were prepared on site for strength and durability tests. The test results are as follows:

The slump and air content test performed on the fresh concrete gave a result that satisfied the targeted values. The targeted slump before shooting was between 2.8 to 5 in. (70 to 130 mm), and it was measured to be 4.3 in. (110 mm). The targeted air content after shooting was between 3 and 6%, and it was measured to be 4.6%. Thus, both slump and air content were satisfied.

Compressive strength and flexural strength were measured only at 28 days. The compressive strength was 6570 psi (45.3 MPa), which is higher than the targeted 5000 psi (35 MPa); flexural strength was also higher than the targeted 720 psi (5 MPa), measured as 770 psi (5.3 MPa).

Durability was evaluated through three kinds of tests: rapid chloride permeability test, freezing-and-thawing resistance test, and surface scaling test. Rapid chloride permeability test was performed at 28 days on a core specimen. The result was 876 coulombs. Any value below 1000 coulombs is considered to have very low permeability. The freezing-and-thawing resistance test was conducted by "Type A," which is a method of freezing and thawing in water, and then the relative dynamic modulus is measured

Fig. 3: Construction of tunnel portal using cellular sprayed concrete

Fig. 4: Spraying at tunnel portal

Fig. 5: Carving regional symbol at tunnel portal

every 30 cycles up to a total of 300 cycles. The relative dynamic modulus after 300 cycles of freezing and thawing was 87%, which is higher than the criteria of high durability performance, 80%. The surface scaling resistance test was performed by repeating freezing and thawing for 50 days with the concrete surface saturated with 4% calcium chloride solution; the amount of peeling and the state of aggregate exposure on the surface was measured and observed. As a result, the surface scaling resistance was excellent and ranked as Grade 1 in the ASTM C672 standard and measured below 0.1 kg/m^2 in the SS 13 72 44 standard.

CONCLUSIONS

The steel reinforcement was placed and tied according to the shop drawings for the tunnel portals, and then high-performance concrete was placed by shotcreting using a modified concrete pump and boom and cellular sprayed concrete. Cellular sprayed concrete is a very simple and economic method to produce a high-performance shotcrete by adding cellular material and silica fume into an ordinary low-slump ready mixed concrete.

High volume placement of high-performance cellular sprayed concrete was possible in shooting the bulk of the thickness. After shooting, the final layer was carved and colored to create the natural rock patterns. This technique is an eco-friendly technology that harmonizes with the surrounding landscape by creating natural rock shapes and coloring the placed high-performance shotcrete before it hardens. The carving and coloring after shooting met the requirements of the local community to represent their region. Figures 6 and 7 show some of the beautiful regionally symbolic tunnel portals constructed in Korea by the Korea Expressway Corporation.

Fig. 6: Regionally symbolic tunnel portals at Pohang

Fig. 7: Regionally symbolic tunnel portals at Sangju

Kyong-Ku Yun *is a Professor at Kangwon National University Chuncheon-si, Gangwon-do, South Korea. He received his PhD from Michigan State University, East Lansing, MI, in 1995. His research interests include shotcrete and concrete materials. Recently, he has been heavily involved in shotcrete research and has consulted on the shotcrete material and overall procedures for this infrastructure project.*

Yong-Gon Kim *is CEO of Daesang E&C, a leading Korean company for shotcrete research and application. He received his PhD from Kangwon National University in 2010, with an emphasis on latex-modified concrete and steel fiber-reinforced concrete. His research interests include shotcrete application.*

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2017 OUTSTANDING INTERNATIONAL PROJECT

Project Name
The Regionally Symbolic Tunnel Portals at Expressway

Project Location
Gangwon-do, South Korea

Shotcrete Contractor
Daesang E&C

General Contractor
Doosan E&C

Engineer
Daesang Engineering Co.

Material Supplier
Daesang E&C

Project Owner
Korea Expressway Company, Korea

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2017 Outstanding Pool & Recreational Project

Recreating a Masterpiece: A Successful Marriage of Cast-in-Place and Shotcrete

By Bill Drakeley and Kerri Allmer

DRAWING INSPIRATION

Frank Lloyd Wright continues to leave his mark on the world of architecture, design, and construction. This project, located in Bridgewater, CT, drew its inspiration directly from Wright's architectural masterpiece, Fallingwater, a house designed to rise above the waterfall over which it is built.

Wright's philosophy of organic architecture places strong emphasis on harmony between art and nature. Simply put, the architecture must seamlessly blend into the environment and use site-appropriate shapes and materials. This design principle does not mean that all structures must be freeform, per se; they can be linear and still be considered an organic fit if it complements its natural surroundings.

The client's home, a modernist approach to a multi-tiered, open-air glass and concrete installation, exemplified organic architecture and already bore striking similarities to Fallingwater (Fig. 1). Using this as the starting point, the design of the pool became a direct reflection of the existing straight-lined house and the surrounding landscape. The result was an upper two-sided vanishing edge swimming pool with vertical spillway drops into varying catch pools that meander along the hillside slope to the bottom of the structure 20 ft (6 m) below, reminiscent of the Fallingwater house perched atop its cascading waterfall.

Fig. 1: Home inspired by Frank Lloyd Wright's "Fallingwater" design

OVERCOMING DIFFICULT TOPOGRAPHY

The house was built into a ledge pocket, and the surrounding area was a very steep vertical slope comprised of boulders, rock, and organic peat. This mixture of materials coupled with sloped conditions would not support a pool structure, so we began with rock and ledge removal down to a workable substrate. Once excavation was complete, we brought in a soil scientist and engineer to ensure the pool structure would not need to contend with differential settlement.

Due to the topography and geological conditions of the site, it was necessary to use cast-in-place concrete for supporting walls and footings. However, the restricted work area and its elevated accessibility could not have been completed economically by any other means besides the proven shotcrete methodology. Therefore, we needed to apply concrete via the shotcrete process into and on top of a cast-in-place formed wall and foundation. Two different applications of concrete were successfully combined because the high-velocity impact of shotcrete on a hardened, existing concrete surface creates excellent bond and results in a monolithic structure, free of any cold joints (refer to ASA Pool Position Statement #5, "Monolithic Shotcrete for Swimming Pools (No Cold Joints)").

Our first step was to cast the supporting concrete foundational walls, footings, and locking mechanisms. We then installed additional connecting reinforcing bars from the concrete foundation that would penetrate up and into our shotcrete pool structures.

Once the connecting reinforcing bar was completed, we proceeded with forming and the remaining reinforcing bar installation. Unlike the cast concrete substructure, our forms were one-sided, rough-sawed lumber and 3/4 in. (19 mm) sheets of plywood. The entire pool installation was out of ground and required some intricate formwork. The steel reinforcement was Grade 60, No. 4 and No. 5 (No. 13M and No. 16M) bars, including 12 in. (300 mm) and 6 in.

Fig. 2: Although intricate forming was required for this out-of-ground pool construction, the use of sustainable shotcrete resulted in a material savings of 50% due to needing only one-sided forming

Fig. 3: Reinforcing bars, non-vibrating rigid forming, and a roughened SSD bond plane were installed to connect the cast concrete foundation and the shotcreted portions of the pool structures

(150 mm) spacings, all double cage. All reinforcing steel was rigidly installed and free of oil and contaminants that could affect performance.

The shotcrete method was also attractive to the client because of the sustainable attributes the process provides. Using shotcrete on this project, we provided a labor and material savings of approximately 50% over conventional formwork, as it did not need to be designed for internal liquid concrete pressures, and only required one-sided forming (Fig. 2). Additionally, the work was performed nearly 50% faster overall due to the reduced formwork. The cost savings with materials and man power is evident when compared with the formed foundation on this same job.

A SUCCESSFUL MARRIAGE

Two months after the cast-in-place foundational walls and footings were installed, we began the process of marrying the existing cast concrete with sprayed concrete. As explained in ASA Pool Position Statement #5, "the construction of a monolithic shotcrete pool shell is not constrained by time limits as long as proper techniques are observed from surface preparation to mixture design, to the shooting velocity of the concrete itself." This means that concrete can be applied via the shotcrete process to an existing concrete surface (cast or shot) at any point in the future, so long as the surface is prepared properly prior to installation (Fig. 3).

Over the course of 5 days, we completed the wet-mix shotcrete placement onto the pre-existing formed concrete and reinforcement of the four interconnecting swimming pools. The first few days were spent shooting the bulk of the main pool and some of the thicker wall-to-floor junctions. The final days were focused on the detail of the vanishing edge and all the spillway lower pools. Although the pool is not that large dimensionally, the attention to detail to meet the required tolerances was critical.

Using the shotcrete process for this project allowed us to achieve a successful structural installation and watertight

Fig. 4: Wet-mix shotcrete placement against an existing cast-in-place structure created a monolithic, watertight concrete vessel. The marriage of these two placement techniques was completed without bonding agents or expansion joints

connection between two different concrete placement methods, without bonding agents or expansion joints. Bondability and water-tightness were easily accomplished using the methods outlined in ASA Pool Position Statement #5. All next-day shooting and connecting joints were prepped to a saturated surface-dry (SSD) condition with a roughened bond plane. The high-velocity impact of the fresh cement paste of the shooting process penetrated and comingled with the prepared receiving substrate, which forms an excellent bond. This is why swimming pools built with properly prepared surfaces and proper placement techniques create a monolithic structural vessel with no cold joints.

Although the shotcrete took nearly a week to complete, there are no cold joints and all interconnecting pools are monolithic and watertight (Fig. 4). After the concrete installation, the pool was water-cured to ensure strength gain and water-tightness. Compressive strength tests after a 28-day wet cure were between 6000 and 7500 psi (41 and 52 MPa).

FINISHING TOUCHES

We continued following Wright's concept of organic architecture by selecting finish materials based on their harmony with the surrounding environment. Native stone veneer for the vertical spillway walls were chosen to match the existing house foundational stone colors. Roxbury Granite used for cladding on the pool's entrance steps and perimeter benches were sourced from local quarries. The colors found in the Pennsylvania Select Bluestone treads and Vermont slate tile are reminiscent of stone found throughout the area, while the IPE decking surrounding the pool reflects the wooded border of the property. A medium grey plaster finish creates a clear blue surface, mirroring the floor to ceiling windows of the house above. On an overcast day, the clouds are reflected in the pool, further interweaving the structure with its surrounding environment (Fig. 5).

This project's success is especially important to the pool industry, as it refutes the outdated conception that cast-in-place water-holding structures must have expansion joints and bonding agents to be watertight. It is also an effective

Fig. 5: Beautiful reflection of clouds

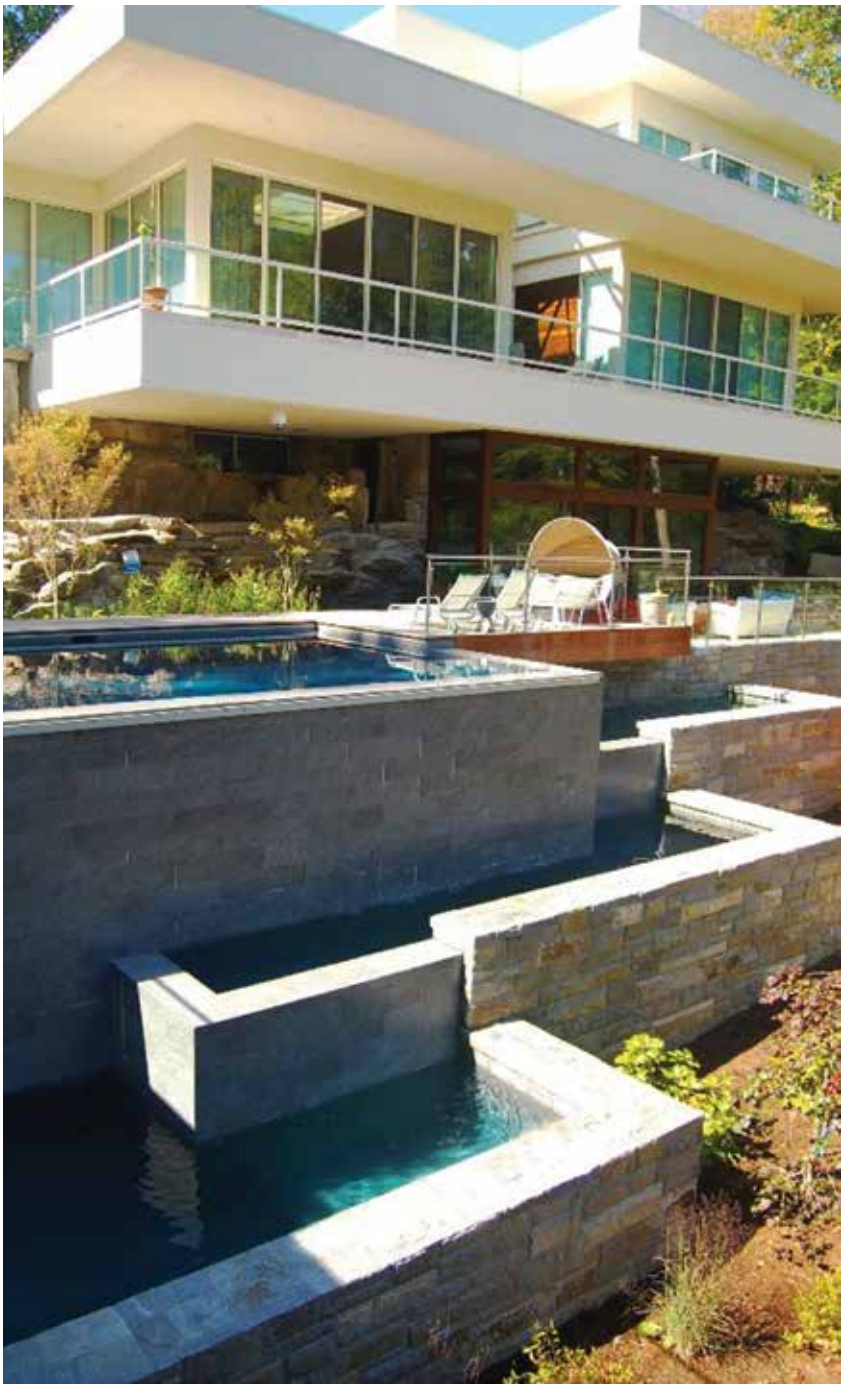

Fig. 6: The final product is a tip of the hat to Frank Lloyd Wright's "Fallingwater" and his philosophy of organic architecture: blending a structure into its surrounding environment

case study of ASA Pool Position Statement #5 by creating a monolithic concrete structure using two different concrete applications. This water feature is confirmation that the shotcrete process not only creates a watertight bond to other concrete surfaces, but can be used in conjunction with leading architecture and design that satisfies and recreates world-renowned architectural works (Fig. 6).

Editor's note: ASA Pool Position Statement #5, along with ASA's other freely available position statements, can be found at ***www.shotcrete.org/pages/products-services/shotcrete-resources.htm****.*

2017 OUTSTANDING POOL & RECREATIONAL PROJECT

Project Name
The Scheinberg Residence

Project Location
Bridgewater, CT

Shotcrete Contractor
Drakeley Pool Company

General Contractor
Tara Construction and Development

Architect/Engineer
Drakeley Industries,* Watershape Consulting

Material Supplier/Manufacturer
O&G Industries

Equipment Manufacturer
Putzmeister*

*Corporate Member of the American Shotcrete Association

Bill Drakeley *is Principal and Owner of Drakeley Industries and Drakeley Pool Company. Drakeley holds the distinction of being the first and only member of American Concrete Institute (ACI) Committee 506, Shotcrete, from the pool industry. He is also an approved Examiner for the ACI Certified Nozzlemen program on behalf of ASA, 2016 President of ASA, an ASA Technical Adviser, a Genesis 3 Platinum member, and a member of the Society of Watershape Designers as well as Chairman of its Advisory Board. Drakeley teaches courses on shotcrete applications at the Genesis 3 Construction School, World of Concrete, and numerous other trade shows. He is a contributor to* Shotcrete *magazine and other industry publications.*

Kerri Allmer *is the Office Manager of Drakeley Industries, a design and structural shotcrete consulting firm specializing in swimming pools, water tanks, tunneling, and other infrastructural shotcrete applications. She also serves as Office Manager of Drakeley Pool Company, a specialty watershape design, construction, and service firm in Bethlehem, CT. Allmer has developed and produced educational materials on pool shotcrete construction for multiple pool trade associations including NSPF/Genesis and NESPA. She has also partnered with Bill Drakeley on technical presentations given to the architectural and landscape architectural industries. Allmer received her bachelor's degree from Quinnipiac University, Hamden, CT, and her master's degree from West Virginia University, Morgantown, WV. She is currently a student of Genesis 3 University, pursuing membership in the Society of Watershape Designers.*

All ASA members and subscribers have access to the electronic version of *Shotcrete* magazine. A link to this e-magazine is sent as an item in the "What's in the Mix" e-newsletter. To ensure that you receive access to every issue of the electronic version of the magazine, send your e-mail information to info@shotcrete.org.

2017 Outstanding Pool & Recreational Project

Three Tier Vanishing Edge Pool

By Ryan Oakes

Mark Dorsey, owner and lead designer at Asheville, NC-based Medallion Pool Company, called us with a unique pool to shoot. As with most of their projects, unique isn't the only quality. Often, Medallion Pool Company sends us to some harrowing locations: on the side of a mountain, in a deep valley, or in some form or fashion a difficult job to get to. This one was easy to get to, though 250 miles (400 km) from our shop and slated to be larger than our volumetric batch trucks could carry in one trip. Thus, the first thing we had to do was to coordinate a local reload and batching point.

Dry-mix shotcrete materials are typically delivered in either pre-packaged bagged form or volumetric batch trucks. For swimming pools, using pre-packaged material is practically unheard of these days, though it was once considered a viable method. The beauty in the pre-packaged method is that quality control of the dry material is always dependable. The ugly is the cost. When just shooting a few cubic feet (m^3), it works, but when delivering 80 yd^3 (60 m^3) in a day is the goal, it becomes cost prohibitive, at least for the swimming pool industry.

This is where volumetric batching comes in. The down side of volumetric site batching is that it is hard to keep aggregate piles dry, which is essential to success in the dry-mix shotcrete process. Ideal aggregate moisture levels are in the 3 to 5% range. The upside is that we don't have to use pre-dampeners because the aggregate moisture is usually higher than 1%. Our approach has been to set up batching facilities across the state where we store our own aggregate under covered facilities for reloading, along with bulk cement reloading via storage silos, just like a concrete ready-mix plant would do.

This works great when we are working somewhere near one of our facilities, but occasionally, as in the case in Johnson City, TN, no such facility would be nearby. We have accordingly become rather adept at coordinating reloads with local ready-mix plants where we don't have a facility. We have samples of their aggregates shipped to us to ensure we can work with the materials and review the gradation reports to ensure they fall within the parameters of our mixture design. Shooting preconstruction test panels for a residential project to completely assure that the mixture design is adequate is not typical, so we aim for using concrete mixture designs producing higher strengths than most standard pools. Our base mixture design produces an average 28-day compressive strength of 5680 psi (39.2 MPa), so meeting the ASA-recommended 4000 psi (28 MPa) leaves a little room for error. We do like to shoot panels when on a job, particularly when using an aggregate that we haven't tested before. That way we can later test the panels to understand the variances in mixture design for those particular aggregates.

Once we had a ready-mix facility that would work with us, we coordinated the job with Medallion. Fortunately, on their last job, their superintendent had given us a set of plans so we would know that a complicated pool would be coming our way. This pool would take approximately 80 yd^3 (60 m^3), but there was no way to shoot this one in a day. We weren't sure until we arrived, but we knew it was at least a 2-day shoot, if not more. If it were poured-in-place, it would have taken a week or more to pour. Therein lies the beauty of shotcrete, wet or dry—speed of project and reduced forming labor and materials. On a project like this, dry-mix really shines. The number of times we had to stop placement during the shoot was uncountable, and if using wet-mix, may have pushed the concrete dispatcher into a fit of fury. Trying to schedule loads of concrete for wet-mix would be tough on a project as broken up and with as much detail as this one.

The client wanted a vanishing edge pool, also called an infinity pool. The site is perched on a hill overlooking a lovely golf course near Johnson City. They wanted an edgy, modern design that was unique, as well as creating a pool for multiple purposes. This pool would have a swim jet system, 24 spa jets, contoured lounge seats, bar stools, a separate spa, and a shallow water lounging area all connected with three separate bodies of water and several troughs to carry water from one feature to the next. As pools go, this one is about as complicated as one can get in such a small space. Also included was a set of stairs and a planter adjacent to the pool, separated just enough to let water pass between the steps and the raised spa. Mark knew he had to transition the users from a raised area down to the main pool area, so he used the spa and sun shelf to do that.

Our job was shooting the shell. Fortunately, Mark is a seasoned builder with one of the best superintendents on the East Coast. His superintendent, Joe, had given us enough information to know that we needed to show up a day before the shoot to pull ground wires and walk through the project. Joe had a story pole ready and walked us through everything. Mark, being an engineer by profession, carefully designed the pool so that Joe could fabricate most of the pool forms and reinforcing bar in their shop, then bring them to the site for installation.

Joe stayed on the job for the entire shoot, aiding in stripping the forms and ensuring that the shell was built exactly to his plan. We believe any pool builder should do the same, especially when building such highly technical and detailed projects like this.

Rigid forming was used because this pool had a great deal of tile installed and the straight walls would minimize any rendering of the walls prior to tilework. The rigid formwork proves great for the shotcrete process (Fig. 1). It provides a sturdy form to shoot against so the plastic concrete is not vibrating and moving, as well as providing a rigid base for securing the reinforcing steel. Finally, our crew members could move around the project, climbing over forms without fear of collapse.

Some of the form supports were buried in the substrate, but in a manner that made it easy to remove them after the form had served its purpose. This was particularly true in the spa walls. Often, spa walls are shot by tying thin peg board to the reinforcing steel, stripping it after shooting onto it, then placing a flash coat on the side where the pegboard was removed after preparing the surface to receive new material. A preferred method is to set a rigid form such as Joe did for us and shoot to the desired finished surface. That form needs to be easily removed, so we left holes in the floor around the support jacks for the forms. Joe would later fill these holes with a non-shrink grout. On the vertical surfaces, we typically dig out a support hole wider at the surface and narrower at the base, then shoot it back in while using a blow pipe (air lance) to keep rebound out of the hole. On a horizontal surface such as a floor, filling the temporary support holes later with grout serves the dual purpose of allowing groundwater to escape during the construction process without putting hydrostatic pressure on the shell.

This project had so much forming detail and tight plumbing to shoot around that we found it necessary to remove some of the previous day's shotcrete due to trapped rebound. Being prepared with chipping hammers that run off air from the compressor truck for the dry-mix machine serves well for this purpose. We made quick work

Fig. 1: Rigid and easily removable forms allow for sturdy steel work and shotcrete placement while being able to strip the forms and shoot the other side

of the previously shot areas, then the substrate was cleaned and brought to a saturated surface-dry (SSD) moisture condition before shooting the repairs back in with fresh shotcrete. The dry-mix process is great for this because we can use high-volume air flow, 825 ft^3/min (24 m^3/min) in this case, along with the water from the nozzle before sending the dry concrete materials down the line. On a multi-day project like this, we can also clean and wet the surrounding surfaces from the previous day's shoot periodically during the day to aid in wet-curing the green concrete shell.

Thirteen different sets of plumbing lines were maintained under pressure during the shoot so that if any line were compromised, we would know it instantly. Shooting around this much plumbing is difficult and the use of a blow pipe makes for better placement of material. Typical swimming pools have pipe sizes anywhere between 1.5 and 2.5 in. (38 and 64 mm), but more complicated pools like this one have larger pipes ranging from 2.5 to 6 in. (64 to 150 mm) or more. This makes for particularly difficult shooting to provide full encapsulation around such large obstructions and again, the use of a blow pipe is beneficial to move rebound out of the work space.

Shooting steps next to the spa was tricky work. The solution was simple, however. Joe formed out the spa with two

Fig. 2: The enormous amount of hand carved detail in the benches and stairs can be seen in this photo

Fig. 3: Spectacular view with top two infinity tiers of pool

sides and set the formwork for us. Attaching sheet foam and splitting the form allowed us to shoot the channel underneath that would carry the water back to the pool. When using the shotcrete process, forming requires a different line of thinking than the pour-in-place method.

The spa benches and benches in the pool were also unique items to shoot (Fig. 2). These would be contoured to match the shape of a fiberglass spa. This is a detail that Medallion uses a lot, so we were familiar with the process to pull this off. Joe provided us with a handheld plywood template that Mark had designed so there would be no error in communication when trying to explain the exact shape of the benches. The nozzleman would eyeball the shoot, then check it with the template. Once he shot the finished surface, the finishers used the template again to rough cut the shape as a screed rather than their finishing rods. Wood floats from there would finish the surface to the desired texture. A good nozzleman can shoot close to the final shape and makes this aspect of the work go quickly.

No great job like this is complete without something going wrong. We ran into a mechanical difficulty when a mix auger on one of our batch trucks snapped. Fortunately, we were close enough to the reload facility that we could get by on the remaining volumetric batch trucks and even had enough capacity to shoot some fountains in nearby Asheville, NC, on the way home. Had we not sent an extra batch truck, this would not have been possible, so preplanning really saved the day.

In the end, a strong understanding of the shotcrete method, good planning from both Medallion and ourselves, and great support from Medallion's on-site superintendent allowed us to show up and shoot the job in 2 days outside of

Fig. 4: Second layer flowing into third and bottom tier of pool

travel time. Medallion knew how to form the pool properly and all the reinforcing steel was well placed, so no corrections were needed on our part. Medallion's ability to visualize a complicated project with a wide variety of specialized details made it easier for us to identify where we needed to start and finish our work. The guidelines for shotcreting, as

2017 OUTSTANDING POOL & RECREATIONAL PROJECT

Project Name
Three Tier Vanishing Edge Pool

Project Location
Johnson City, TN

Shotcrete Contractor
Revolution Gunite*

General Contractor
Medallion Pool Company

Architect/Engineer
Mark Dorsey/Medallion Pool Company

Material Supplier/Manufacturer
Revolution Gunite*

Equipment Manufacturer
Gunite Supply*

Project Owner
Chad and Cindy Thomas

*Corporate Member of the American Shotcrete Association

Fig. 5: View of top tiers showing the spa and built-in benches within the pools

established by ASA and ACI, can sometimes seem routine and appear as simple as walking down the street, but when tasked to do a high-quality job that is very technical in nature, having practiced those guidelines daily really makes the difference in completing a great project (Fig. 3, 4, 5).

***Ryan Oakes** is a Managing Partner at Revolution Gunite and is a licensed pool contractor in North Carolina and Virginia. Oakes has been designing and building watershapes in the United States and abroad, from swimming pools to art pieces and even aquaculture systems, for the past 20 years. With a mission to change the way gunite is perceived and applied, Oakes started down a path of education for himself as well as their staff. He is an active member in the Genesis Design Group, which educates contractors around the world in various aspects of the pool building process, including the shotcrete process. Oakes is SWD Registered (Society of Watershape Designers) and an Allied member of the American Institute of Architects and member of the American Pool & Spa Association. In 2017, Oakes was appointed by the ACI Technical Activities Committee as a member of ACI Subcommittee 506-H, Shotcrete for Pools, and a member of ACI Committee 506, Shotcrete. He was recently appointed to the Board of Directors for ASA while also serving as Vice Chair of the ASA Contractors Qualification Committee and a member of the ASA Pool & Recreational Shotcrete Committee.*

***Revolution Gunite**, a Corporate Member of ASA and ACI, has a mission to not only educate and train its staff but to also educate its builders so that they, too, play their role in a quality shotcrete product. Revolution Gunite provides dry-mix shotcrete services to pool builders and other contractors in North Carolina and Florida, as well as parts of South Carolina, Virginia, and Tennessee.*

Pier 57 Repair and Improvements

By Tait Pirkle and Marcus Jeffreys

Pier 57, now referred to as "SuperPier," is situated on the Hudson River and sits at the end of 5th Street on the West side of Manhattan, NY, just south of the renowned Chelsea Piers sports complex and marina. The pier, which was opened in 1954, rises two stories above water level and has a metal enclosure with bay doors and an Art Deco-style façade at the west end. Interestingly, the pier rests atop three submerged buoyant concrete caissons that were built north of Manhattan in Rockland County, New York, and subsequently floated down the Hudson to the Pier 57 site. At the time of its construction, Pier 57 was the largest dock building project ever undertaken by the City of New York and has been listed on the National Register of Historical Places.

Throughout its history, Pier 57 served many purposes, including a shipping and storage terminal, bus depot, and even a temporary detention facility for arrested protesters during the 2004 Republican National Convention. RXR Realty is the co-developer of the project under the oversight of the Hudson River Trust. The contract was to rehabilitate the pier and repurpose it into a food market, office complex, and rooftop garden. When completed, the 560,000 ft^2 (52,000 m^2) mixed-use development, with an estimated rehabilitation cost of $350,000,000, will anchor tenants Google and Bourdain Market, a food hall.

A crucial component of the overall project was the rehabilitation of the pier's concrete support structure, which was originally slated to be a form-and-pour repair project. However, it was eventually decided that the shotcrete repair method would be more efficient, cost-effective, and structurally sound. The shotcrete contract was awarded to Eastco Shotcrete, LLC (Eastco).

The shotcrete portion of the project called for the removal of deteriorated concrete, replacement of steel reinforcement using No. 4 and 8 (No. 13M and 25M) epoxy-coated reinforcing bar and reinforcing bar couplers, installation of welded wire reinforcement, and the shotcrete placement. The work was divided into three repair types: vertical girder (shallow repairs with depths of up to 6 in. [150 mm]), moderate girder (deterioration not completely through the girder with depths up to 1 ft [0.3 m]) (Fig. 1), and severe girder (complete deterioration through the entire girder with depths of 2 ft [0.6 m]) (Fig. 2). The project totaled 2600 ft^2 (240 m^2) of vertical repairs, 60 ft^2 (6 m^2) of moderate girder repairs, and 1200 ft^2 (1100 m^2) of severe girder repairs. The repairs that are visible to the public were trimmed back and received a flash finish coat. The remaining repairs (out of sight) were gun finished and cured with a spray-applied compound.

The severe girder repairs varied significantly in length and posed the biggest challenge because the sharp taper had

Fig. 1: An example of a moderate girder repair

Fig. 2: An example of a severe girder repair

to be recreated and were 2 ft (0.6 m) thick. After removal of the unsound or deteriorated concrete, individual custom reinforcing bar cages were installed. The cages had to follow the original taper and allow for the specified concrete cover over the reinforcement (Fig. 3). The tapered bottoms of the severe girder repairs were formed using 8 ft (2.4 m) long, 8 in. (200 mm) high wood forms. To mitigate the weight, the prefabricated forms were floated in place, pieced together, and then accurately positioned between the girder's double-sided reinforcement cage (Fig. 4). Eastco's ACI Certified Nozzleman then filled in the bottom form and applied a 3 in. (75 mm) base coat to a simple plywood form connecting the bottom form to the existing top side face of the girder. Typically, during the same tidal shift, the forms were removed and accelerated-set shotcrete was applied in layers to complete the girder repair.

Eastco faced several large and small challenges during the project. This portion of the Hudson River has a severe current and heavy water traffic. The laydown barges, work floats, and other watercraft were in continual jeopardy of being carried down the Hudson River by the swift current. Large boat wakes from nonstop water ferries and other commercial watercraft were commonplace, disruptive, and dangerous. Work floats had to be frequently secured during a given shift not only to allow for the dropping tide but to prevent the floats from ramming into the reinforcement cages, forms, or freshly applied shotcrete.

Productive labor on tidal work is always time-sensitive. Pier 57 is in an upscale part of Manhattan and next to Chelsea Piers Marina, where large luxury yachts are docked for both long- and short-term stopovers. There was a strict noise ordinance limiting work times to between the hours of 6:00 a.m. and 6:00 p.m. Together, the time restriction and coordination with the low tide cycles greatly reduced the amount of productive work hours because the bottoms of the girders had to be constructed during a low tide cycle.

A minor, but memorable, problem was the simple task of unloading materials. Pier 57's entrance is located on the West Side Highway, which has severe traffic congestion. A busy biking and running path runs parallel to the highway and adjacent to the pier's relatively narrow garage entrance. All deliveries needed to be scheduled days in advance due to the numerous other construction activities and subcontractors working inside the covered pier. Materials had to be unloaded in the seaward end of the long pier, where even a medium-size flatbed truck, much less a 45 ft (14 m) long tractor-trailer, had issues navigating in the limited space. It was problematic just entering and turning around to exit the pier. Ordinary, simple deliveries often became the biggest problem of the work week.

As with all jobs, personnel safety on Pier 57 was a concern and a priority. A Health & Safety Plan (HSPA) and a Job Hazard Analysis (JHA) were implemented before mobilization and issued to all employees. The JHA included the hazards associated with working on a work barge and float stages, with special considerations to access and egress (Fig. 5). All employees were suited with proper personal protective equipment (PPE), including a Coast Guard-approved personal flotation device (PFD) and a fitted respirator. Mandatory weekly toolbox talks and safety meetings were attended by all employees.

Fig. 3: A reinforcing bar cage using reinforcing bar couplers

Fig. 4: The installation of a wooden form to help create the right taper of the girder bottom

Fig. 5: Eastco's ACI Certified Nozzleman applying shotcrete

Pier 57 was a logistically challenging project that required inventiveness, strategic planning, and a comprehensive

understanding of the Hudson River. It challenged the crew to be efficient and flexible, and highlighted the quality of Eastco's personnel, especially the ACI Certified Nozzlemen. The project was a huge success that demonstrated the effectiveness and efficiency of accelerated-set dry-mix shotcrete (Fig. 6). Simple, relatively light forms took the place of a heavy-duty form system that would have been required with a form-and-pour repair. The shotcrete forms were routinely erected and removed during the same or following work shift. Had the repairs been form-and-pour with totally enclosed forms, it would have taken days to construct, erect, and remove just the formwork. It's certain the rough current and or wave action would have damaged or destroyed the form-and-pour forms before completion.

Of all the many interesting places to visit in New York City, once completed, Pier 57 will be a destination point for tourists and locals alike to enjoy a beautifully refurbished piece of New York City history (Fig. 7).

Fig. 6: A completed severe girder repair shot with a gun finish

Fig. 7: A rendition of a completed Pier 57

***Tait Pirkle** is a Project Manager for Eastco Shotcrete, a New Jersey-based shotcrete contractor which specializes in marine and other rehabilitation projects. Working part-time in the field until his 2015 graduation from the University of Alabama, Tuscaloosa, AL, he now manages special projects for Eastco. He serves as Chair of the ASA Marketing Committee and is a member of the American Concrete Institute (ACI) and the International Concrete Repair Institute (ICRI).*

***Marcus Jeffreys**, an ACI Certified Nozzleman in both wet- and dry-mix processes, has been in the industry since 2007. He became a certified nozzleman in 2010. He began working for Eastco Shotcrete in 2015, where he is a Field Supervisor and specializes in marine and other concrete rehabilitation projects.*

2017 OUTSTANDING REPAIR & REHABILITATION PROJECT

Project Name
Pier 57—Pier Repair and Improvements

Project Location
New York, NY

Shotcrete Contractor
Eastco Shotcrete, LLC*

General Contractor
Trevcon Construction Co. Inc.

Architect/Engineer
McLaren Engineering Group

Material Supplier/Manufacturer
King Shotcrete Solutions*

Equipment Manufacturer
Putzmeister*

Project Owner
RXR Realty

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2017 Outstanding Underground Project

Liverpool Central Tunnel High-Level Neck Repairs

By Andy Dunlop and David Thomas

Liverpool's High-Level Neck tunnel (HLN) cannot lay claim to being the city's most famous cavern, but it can justifiably be labeled as being one of the most unusual and challenging tunnels on the entire UK rail network.

To start with, there is just the sheer scale of the structure. Not in length. There are many more that can out-do HLN in yardage terms. However, there are few that can challenge it on its soaring 49 ft (15 m) height from track level to tunnel crown (Fig. 1).

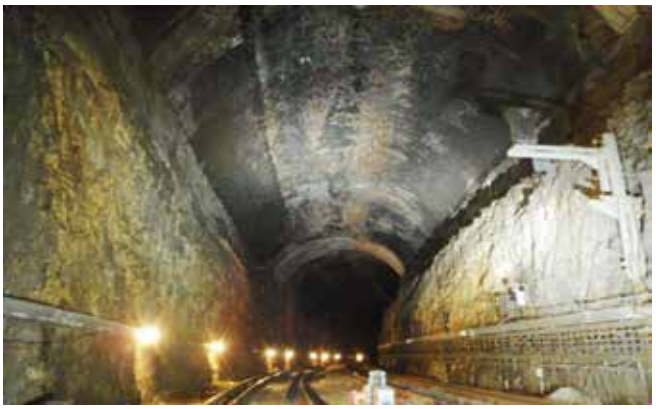


Fig. 1: Not your typical tunnel!

This extraordinary height is a quirk of the tunnel's long history and change in use over the years. Originally opened in 1892 as a tunnel of "normal" proportions serving Liverpool Central station, the structure became redundant in 1966 when Beeching closed the overland station. The Beeching cuts were a reduction of route network and restructuring of the railways in Great Britain, according to a plan outlined in two reports—*The Reshaping of British Railways* (1963) and *The Development of the Major Railway Trunk Routes* (1965), written by Dr. Richard Beeching.

The tunnel was given a new lease of life with the arrival of the Merseyrail network, and this is the stage in its life where HLN evolved into the cavern that it is today.

The invert of the tunnel was lowered to connect with low-level platforms at the new Merseyrail Central Station.

While spectacular to the casual observer, the height of HLN means access is extremely difficult and maintenance and repair of the structure without causing massive disruption to network operations is an ongoing headache. In short, it is a structure that no Asset Manager would choose to have on their patch.

Previous repairs in 2010, involving brickwork repairs and fiber-reinforced dry-mix shotcrete, had been carried

BACKGROUND

- 820 ft (250 m) long tunnel dating back to the late 1800s.
- The tunnel is unusually proportioned—being 33 ft (10 m) wide and 49 ft (15 m) high—possibly the tallest on the UK network.
- A key piece of infrastructure on the Merseyrail network, one of the most heavily used UK railway networks outside London.
- Historically, maintenance and renewal interventions have been extremely difficult and inefficient.
- Inspections showed that the tunnel brickwork lining had severely deteriorated.
- There was a significant risk of failure of the brickwork that would result in severe and potential lengthy disruption to the Merseyrail network.

STATS

- New concrete lining required for a 541 ft (165 m) section of the tunnel.
- 120-year design life required with minimal future maintenance liability.
- Construction of intricate crash/deck working platform allowed works to be undertaken safely without disruption to running of trains beneath.
- Innovation: refinement of RAM Arch system for permanent works use and fabrication of bespoke installation machine.
- 994 yd^3 (760 m^3) of specialized concrete applied by tracked robotic machine.
- 990 RAM Arch reinforcement panels installed.
- 32,000 safe hours worked.

out during nighttime work. This was costly and had numerous issues, including access, manual handling, dust, productivity, confined spaced working, and logistics issues.

Following a Network Rail inspection in 2015, it was evident that the remaining brickwork in the tunnel soffit had been found to be worse than feared. Effectively, the mortar had degraded to a point where it was nothing more than a thin crust, much of the brickwork was hollow, and most of it needed repointing.

It was immediately obvious that using conventional methods to repoint such a huge area would be prohibitive in terms of both cost and time, and we had to come up with an alternative repair solution.

ACCESS HELD THE KEY

One of the biggest challenges faced in 2010 was getting materials, equipment, tools, and men to the workface. Everything had to be brought in by road rail vehicles (RRVs) from more than a mile (1.6 km) up the line, but this route was only available for a few hours each night.

Further research revealed that hidden away in Network Rail's maintenance depot was the old portal entrance to the earlier high-level tunnel entrance (Fig. 2). It wasn't ideal as this portal has an immediate sheer drop to track level and its location in the city center had its own logistical challenges with access too tight for large vehicles.

It was agreed with Network Rail that the old portal could be used to access the tunnel.

A NEW WORKING PLATFORM

With access identified, the next challenge was developing a platform that would create a safe working environment and give better productivity. We certainly weren't going back to the 2010 situation of using a birdcage scaffold that gave us limited working windows.

We came up with a design that would establish a crash deck and working platform high above the railway running along a 540 ft (165 m) section of the tunnel (Fig. 3). The design of the deck meant we could separate the repair work from the trains running beneath, and ticking all the boxes required for creating a safe working environment, eliminating disruption to traffic, and giving huge potential efficiencies.

This was no normal scaffold crash deck. The deck would need to be robust enough to cope with the weight of a robotic concrete sprayer, the thrust from a specialist lifting boom used to install reinforcement mesh to the tunnel, accumulations of concrete rebound from spraying, and any possible fall outs during spraying concrete (Fig. 4).

The best demonstration of the challenge that the deck posed is the fact that three successive specialist scaffolding companies all refused to quote for the work.

RETHINKING RAM ARCH

With the access sorted, our minds turned to the design and methodology of the actual work required to repair the structure.

Fig. 2: The original disused portal is just visible in the background to the left of the train. This was the key to the success of the project

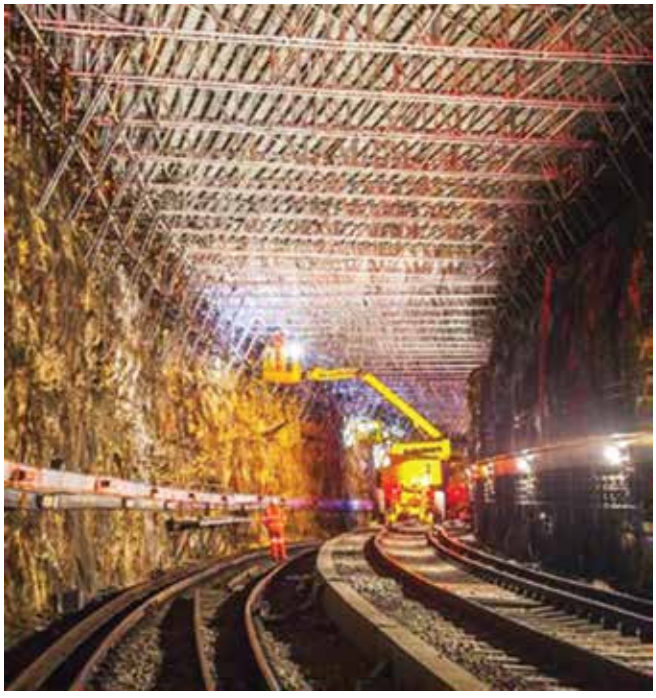


Fig. 3: The access deck from track level

Fig. 4: A fully segregated working platform is created with trains running below

This boiled down to pinning a mesh to the tunnel crown brickwork and then spraying this with a new concrete lining. But, as ever, nothing in HLN is ever that simple.

We had to develop a solution with the designers, COWI (formerly Donaldsons), that met the performance requirements of Network Rail but with several restrictions on the solution, including:

- 120-year design life requirement;
- No L-pins—these would usually be used in similar circumstances to secure steel mesh to the tunnel lining, but the scale of works required at HLN made their use too expensive and slow. Initial calculations showed it would take 12 men 3 months to install the 12,000 L-pins that would be required;
- High-quality mesh;
- No steel fibers; and
- Concrete applied at a thickness suitable to provide Network Rail with a structural layer, enabling them to forget about the brickwork beneath.

The solution to this challenge lay in an innovative technique previously adopted by AMCO for works in other tunnels on the network.

Fig. 5: 990 RAM Arch reinforcement units installed. Bespoke arch lifting machine shown to the left

Fig. 6: Reed B20HP

Known as RAM Arch, the system provides reinforcement panels to support loose and unstable brickwork in tunnels. The use of the RAM Arch panels allowed us to reduce the thickness of concrete from the original 12 in. (300 mm) design down to 10 in. (250 mm) while still providing the required structural layer and 120-year design life.

The next challenge was installing the RAM Arch. In normal circumstances, it is installed by a bespoke arch lifting attachment fitted to an RRV. It was not possible to use an RRV as the RAM Arch would need to be installed directly from the scaffold deck, not from the track below.

We designed and fabricated a mini arch lifter that could be used on the scaffold. The design of the mini lifter had to account for the constraints of working on the scaffold working platform so it had to be as light as possible (with limited thrust so as not to exert too much force down into the scaffold), maneuverable, and easy to use (Fig. 5).

All that had to be done now was to find the best way of getting 1000 yd^3 (760 m^3) of specialized sprayed concrete to the worksite and applying it in a carefully controlled manner.

Our specialized supply chain partner, Gunform International, proposed to design the concrete mixture (Specification C40/50) and use their tracked robotic arm to traverse the scaffold deck and apply the concrete that would be pumped 525 ft (160 m) from the portal.

With the design signed off, all we needed to do was:

- Create an access via the old high-level portal and build our way into the tunnel;
- Build a 540 ft (165 m) long robust working platform 33 ft (10 m) above the track;
- Design and build a new bespoke mini RAM Arch installer;
- Use a robotic sprayer to accurately apply the new concrete lining; and
- Complete the works with trains running below.

Following completion of the scaffold deck constructed during nighttime possessions, we set about installing the RAM Arch. To enable the RAM Arch to be erected, we had to create a base for it to spring off by saw-cutting a 12 in. (300 mm) ledge into the tunnel sandstone and install an array of rock bolts and a ventilation system.

After many weeks of pre-construction trials, concrete testing, and preparatory works, Gunform tracked the robotic arm to the far end of the decking and the first batch of concrete from CEMEX began to pump the 540 ft (165 m) using a REED B20HP pump complete with integrated dosing system (Fig. 6). Everything went perfectly to plan.

The following 6 weeks were a carefully choreographed ballet of concrete production line perfection. Working daytime shifts (8:00 a.m. to 5:00 p.m.) with trains running below, concrete was delivered to the portal from 8:30 a.m. each morning. Each delivery provided enough concrete for approximately 1 hour of spraying (Fig. 7). At the end of each hour, a team of AMCO operatives would descend onto the deck to bag up and remove all rebound material, and half an hour later, the process would begin again.

As the spraying progressed back towards the portal, we could start dismantling the scaffold deck behind it during

nighttime possessions to ensure a rapid demobilization at the end of the project.

The scheme developed and delivered by AMCO in collaboration with Network Rail and specialist suppliers from COWI (design), Crossway (scaffolding), Gunform (robotic concrete spraying), and CEMEX (concrete supply) delivered a robust, long-term repair solution that ensures safe and reliable use of the tunnel for generations to come (Fig. 8).

RESULTS

- Zero accidents;
- Zero train delays;
- On-time delivery;
- Within budget;
- $16.8 M USD (£12m) cost saving against comparable previous works undertaken in the tunnel;
- Collaborative joint team approach between AMCO, Network Rail, and specialist supply chain;
- Widespread acclaim from Network Rail; and
- Solution with a 120-year design life that removes a significant risk of failure from the infrastructure and provides a maintenance free result for generations to come.

Fig. 7: Robot sprayer at work. Remember there are trains running beneath this!

Fig. 8: Job done!

Andy Dunlop *is Managing Director of Gunform International and Director of Gunform (Equipment Supplies) Ltd. He has been involved in sprayed concrete, contracting, and equipment supply for over 35 years. Dunlop is an EFNARC Nozzleman Examiner, Sprayed Concrete Association Nozzleman, and current Chair of the UK Sprayed Concrete Association.*

David Thomas *is a mining and tunnelling engineer and Contracts Manager with 30 years at AMCO Rail. He has been involved with developing new technologies and methodologies within the rail industry.*

2017 OUTSTANDING UNDERGROUND PROJECT

Project Name
Liverpool Central Tunnel High Level Neck Repairs

Project Location
Liverpool, UK

Shotcrete Contractor
Gunform International Ltd.

General Contractor
AMCO Rail

Architect/Engineer
AMCO Rail and COWI (formerly Donaldsons)

Material Supplier/Manufacturer
Cement Concrete (CEMEX), Ram Arch (ISS), and BASF*

Equipment Manufacturer
REED Shotcrete Equipment* and MEYCO

Project Owner
AMCO Rail and Network Rail

*Corporate Member of the American Shotcrete Association

2017 Honorable Mention

Lake Country Wine Tunnels

By James Marifosque and Roger W. Abbott

Lake Country is a municipality located in the Central Okanagan Valley of British Columbia, Canada, which is approximately 250 miles (400 km) northeast of Vancouver. Home to British Columbia's Wine Country, Lake Country offers tourists many activities including watersports, camping, hiking, golf, and ski resorts.

Thanks to the unique weather and soil conditions present in the Okanagan Valley, many wineries and vineyards are situated around the region. Among the many wineries, the O'Rourke Family Vineyards stands out as one of the first to implement a tunnel system below the bedrock to house its wines (Fig. 1).

The tunnels are situated on a 200-acre (0.8 km^2) lot overlooking the water comprising approximately 1000 ft (300 m) of tunnel with four portals, and will be one of the highlights of the location. The first of its kind in Canada, it will be able to house countless barrels and bottles of wine, and people will be able to walk through and enjoy the sights. Storing the wine in this natural area will provide the perfect temperature of around 59 to 61°F (15 to 16°C) throughout the year, along with the perfect humidity (Fig. 2).

Other planned attractions to the winery include a separate ballroom, concert area, and a library housed in the tunnels. Opening date is set for 2018.

CHALLENGES

Abbott Shoring, based out of Vancouver and Penticton, BC, Canada, has provided over 35 years of rock stabilization, drilling, anchoring, shoring, and shotcreting services. Abbott was called in after the tunnels were dug to provide structural overhead shotcrete.

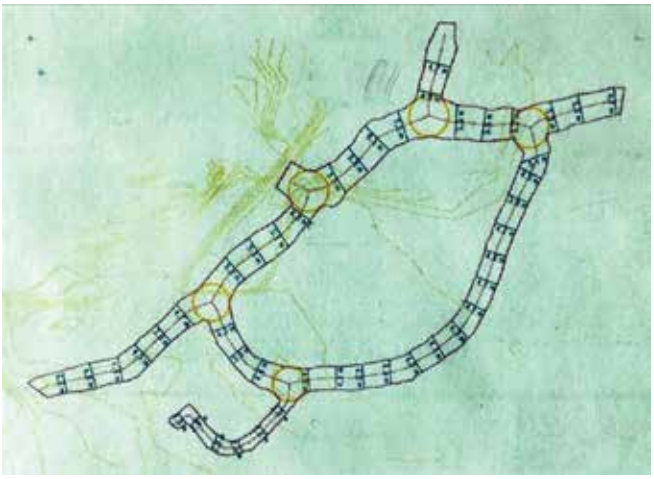


Fig. 1: Tunnel layout

When Abbott arrived on site, the tunnels were already mined. Originally, shotcrete was not part of the plan as the owner wanted a natural rock look, so no consideration was made for shotcrete, only using welded wire mesh, rock bolting, and Tecco mesh for support. However, over time, due to the fractured nature of the rock, raveling was occurring behind the welded wire mesh, requiring de-bagging of the trapped rock fragments. It was felt that without shotcrete support, this could be a costly ongoing maintenance problem, and therefore, the decision was made from a cost and

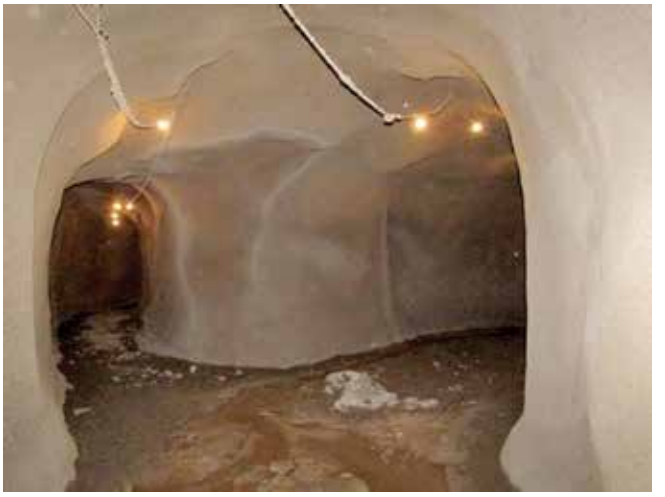
Fig. 2: Main tunnel

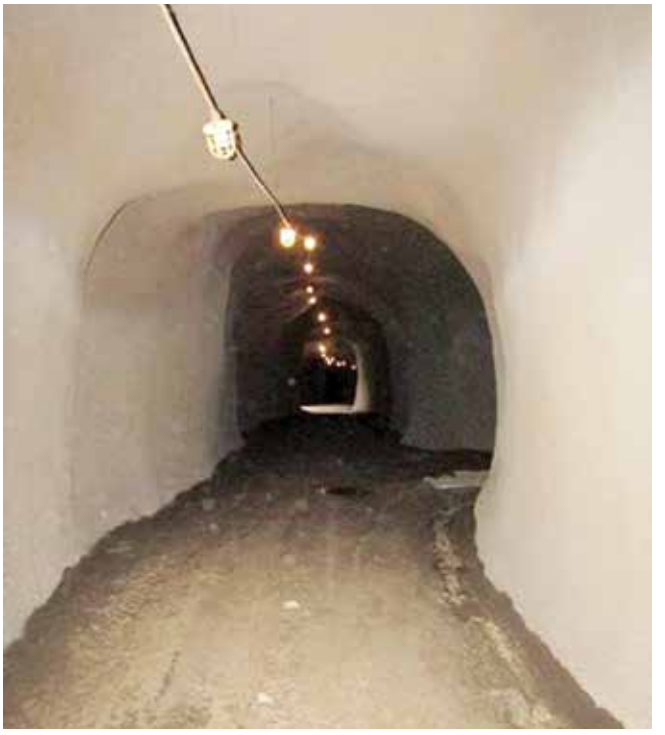
Fig. 3: Tunnel prior to shotcrete

safety perspective to totally enclose the tunnel surfaces with shotcrete. The overhead areas where raveling had occurred were scaled and secured tightly to receive shotcrete without movement or vibration. Where major slips had shown movement and removal of the large blocks of rock could cause further instability, grout tubes were shot in and subsequently grouted once shotcrete had attained 28-day strength (Fig. 3).

Working in confined spaces, as well as having no radio service in the tunnels, provided interesting challenges for the coordination of the shooting over the 1000 ft (300 m) of tunnel. As the shotcrete equipment had to be stationed

Fig. 4: Tunnel portal





Flg. 5: Completed tunnels

outside the tunnel (Fig. 4), traditional hand signals with a few personnel stationed between the gun and the nozzle were used.

Also, because there was a lot of construction happening above the tunnels, care had to be taken to coordinate shooting of the shotcrete with the construction above to reduce vibration and to aid in the set of material.

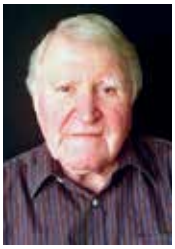
The shotcrete nozzlemen were all ACI-certified for vertical and overhead dry-mix shotcrete.

SHOTCRETE MATERIALS

Overall, shotcrete provided a superior, aesthetically pleasing, long-term solution for the Lake Country Wine Tunnels (Fig. 5). Using quality materials from Basalite—fine tuned to the specific needs of the project along with an experienced shotcrete contractor with ACI Certified Nozzlemen—created a wine cave system to store the vineyard's precious products in an optimum climate and complete safety with reduced maintenance.

Basalite Concrete Products provided the dry-mix shotcrete, which included steel fibers and accelerator, to aid in the overhead structural shooting. Most of this was used for shooting overhead, and a small amount was used for sculpting around the portals. The steel fibers were essential to the structural overhead component of the work, while the accelerator allowed for the quick set of the shotcrete. A silica fume-enhanced mixture was chosen to help with stickiness in shooting overhead, as well as to increase strength and reduce permeability. Shotcrete was placed in thicknesses varying from a skim coat to 6 in. (150 mm) and covered around 39,000 ft^2 (3600 m^2). A total of 456 yd^3 (349 m^3) was shot, which included shotcrete with and without fibers and with and without accelerator.

***James Marifosque**, EIT, is the Industrial Sales Engineer for Basalite Concrete Products, ULC, for the Canadian operation. He graduated from the University of British Columbia, Vancouver, BC, Canada, in 2012 with a Bachelor of Applied Science in civil engineering. He has worked in infrastructure and heavy civil construction, specializing in quality management and materials engineering and testing. This includes concrete, shotcrete, asphalt, and soils. Currently, he in involved with the industrial sales and business development of dry-mix products for Basalite in Western Canada, including British Columbia, Alberta, and Saskatchewan.*



***Roger W. Abbott** is President of Abbott Shoring & Foundations Ltd., whose main focus is shotcrete shoring and underpinning, seismic structural reinforcing, and rock and slope stabilization, in both dry and wet applications. He resides in North Vancouver and has over 40 years of experience with both temporary and permanent shotcrete applications in Canada.*

2017 HONORABLE MENTION

Project Name
Lake Country Wine Tunnels

Project Location
Lake Country, BC, Canada

Shotcrete Contractor
Abbott Shoring & Foundations

General Contractor
Sureway Construction

Architect/Engineer
Geowest Engineering

Material Supplier/Manufacturer
Basalite Concrete Products*

Project Owner
O'Rourke Family Vineyards

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2017 Honorable Mention

Surf Ranch 2.0

By Paul Mendoza

In 2017, Kelly Slater Wave Company set out to accomplish the impossible feat of creating the perfect wave in the middle of the agricultural San Joaquin Valley of California, 100 miles (160 km) away from the ocean. While artificial waves have existed since the 1960s, they have failed to create the hollow "barrel" required for surfing inside a wave curl due to their inability to mimic the size and power of natural waves.

Slater debuted this first-time feat in December 2015, and it was immediately named as a game changer for the world of surfing. The wave that is formed in the pool is 1200 ft (370 m) long and goes in two directions to form both a right-hand and a left-hand wave. High-performance surfing could now happen in landlocked areas and inside stadiums. Surf Ranch project was the first time Kelly Slater Wave Co. set forth to create a competition-worthy wave facility in the United States. The project team was held to a tight schedule to allow for the inaugural Future Classic surf competition (unofficially known as the "Test") to be held at that facility in September 2017. This would be the first wave pool contest run by the World Surf League (WSL), considered by WSL to be "a milestone moment for professional surfing." Shotcrete was an ideal choice for the walls as it easily accommodated the demanding schedule, with production shooting beginning in May 2017 and all operations completed by the end of July 2017.

Fig. 1: Reinforcing bar and formwork prior to shooting condition at south wall, where wall and slope were shot monolithically

Shotcrete was used to shoot the 8 and 10 in. (200 and 250 mm) thick perimeter walls and some of the slopes in the 2250 ft (685 m) long x 235 ft (72 m) wide wave pool (Fig. 1). Concrete North, Inc., poured in place the floor and transitions. The walls were shot in alternating panels to allow for 1 in. (25 mm) sponge rubber expansion joints to be set. Nationwide Shotcrete Inc. (NSI) shot some of the slopes integral with the wall, while the rest of the slope was cast by Concrete North, Inc., prior to the shotcrete walls being placed.

There were two engineering teams: KPFF designed the north, west, and south walls, while Hilts Consulting Group designed the east walls. The east walls were 8 in. (200 mm) thick with a single curtain of No. 6 (No. 19M) bars at 6 in. (150 mm) spacing vertically and No. 4 (No. 13M) bars at 12 in. (300 mm) spacing horizontally. The typical walls for the KPFF portion were 10 in. (250 mm) thick double-curtain No. 4 (No. 13M) bars at 12 in. (300 mm) spacing horizontally with the front curtain of reinforcing bar using No. 6 (No. 19M) bars at 8 in. (200 mm) spacing vertically and the back curtain using No. 4 (No. 13M) bars at 12 in. (300 mm) spacing vertically. Preconstruction test panels (Fig. 2) were

Fig. 2: Preconstruction test panel for cores approving nozzlemen for project
(Photo courtesy of Technicon Engineering Services)

Fig. 3: Completed north wall

shot for evaluation by both engineers and the NSI nozzlemen were found qualified to shoot on the project.

CEMEX was selected to be the ready mix supplier for the shotcrete work. They supplied an eight-bag, 4500 psi (30 MPa) mixture with 3/8 in. (10 mm) pea gravel, 2 ± 1 in. (50 ± 25 mm) slump, and 5 ± 1.5% air entrainment. The plant was less than 2.5 miles (4 km) away from the project site, and this ensured timely delivery of ready mix concrete to the project site.

The use of shotcrete on this project helped eliminate much of the formwork that would have been required were the walls formed and poured using conventional means. This helped reduce prep time required to setup for the shotcrete placement. Using shotcrete, the forms could be stripped as soon as the following day, allowing for efficient reuse of the forms by rotating them along the walls as the shoot progressed. After shooting, the rebound was collected and delivered to a local concrete recycling site.

2017 HONORABLE MENTION

Project Name
Surf Ranch 2.0

Project Location
Lemore, CA

Shotcrete Contractor
Nationwide Shotcrete, Inc.*

General Contractor
DPR/Concrete North

Architect/Engineer
KPFF Consulting Engineers/Hilts Consulting Group

Material Supplier/Manufacturer
Cemex

Equipment Manufacturer
Western Shotcrete Equipment

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The wave pool construction ran on time and was ready (Fig. 3) for the secret-but-rumored competition to take place. The 300 competition invitees were reported to have had a great time experiencing the man-made wave (Fig. 4). After surfing the wave, Filipe Toledo was quoted as saying "It's perfect. It's that wave that we dream about…" and the WSL announced in November 2017 that Surf Ranch will serve as a new stop for the Championship Tour. The WSL commissioner said the technology will change the competitive experience by allowing for waves at any location in the world. The idea of using artificial wave pools for including the sport in Olympic events has been considered when the games take place in inland areas. Nationwide Shotcrete is proud to have taken part in the production of Kelly Slater Wave Company's Surf Ranch competition facility.

Fig. 4: The "Test"

***Paul Mendoza** is an Estimator/Project Manager at Nationwide Shotcrete. He has 10 years of experience in the shotcrete industry, working for shotcrete and concrete contractors in California. He is licensed as an Engineer-In-Training in the State of California.*

2017 Honorable Mention

Rails Steakhouse Wine Cave

By Frank Townsend

Jim Stathis is a thinker and doer in everything he touches. Stathis started working with his hands at a very young age as a craftsman, which enabled him to develop his eye for creativity and make his ideas reality. Rails Steakhouse, located in Towaco, NJ, on a NJ Transit rail stop, was designed and built by Stathis. He later had an idea to build an underground wine cave next to his "speakeasy." Stathis brought in Tom Pirkle from Eastco Shotcrete to advise and help construct the job. Pirkle looked at this as a great opportunity for collaborative job between his company Eastco and Superior Gunite. Together, both companies would collaborate and provide a superior product for both Stathis and Rails Steakhouse.

The goal was to create a realistic wine cave. Stathis started with some color renditions and striations from pictures that caught his eye. This started as a large rectangular area 75 x 35 ft (23 x 11 m). His thought was to have a secret door that led into a small tunnel (Fig. 1) which then opened into a grand dinning space with an adjacent bench seating area. The space was shaped by Stathis, as well as all the reinforcement which included bending, cutting, and welding. With the help of a few Eastco laborers, they installed all the form savers and paper backing. The thickness ran approximately 6 in. (150 mm) thick throughout the space with mostly overhead shooting. The next step was to place the protection for adjacent areas and cover over all the boxouts for future utilities.

What made this project challenging was shooting and finishing this 5000 ft^2 (460 m^2) area of overhead cavernous space without impacting the restaurant. This meant the ideal day to shoot would be on a Monday when the restaurant was closed. Stathis assembled a crew of Superior Gunite, Eastco, local help, and some local college kids. To maintain good airflow in the space, we first had to set up the HEPA filters. Laying out the movement of the nozzle, the line of the hose, and the rebound plan was key to making this happen in 1 day. As we shot, we carved out candle nooks and protected lights and other utility blockouts. Stathis added his artistic flare by carving some family history into the walls as well as making his own stamps of fossils and stamping them in. We started at 6:00 a.m. and finished carving by 7:00 p.m.

For the concrete, we used a 5000 psi (35 MPa) colored concrete mixture from Eastern Materials, a US Concrete Company. We used short loaded trucks for optimal freshness of concrete during placement and used a BASF rapid-set accelerator in key locations.

Curing was accomplished with a wet cure. The exposed shotcrete surfaces were misted and dampened three to four times a day for a week. The following Monday, certain sections of the cave were stained and highlighted (Fig. 2 and 3).

SIGNIFICANCE OF SHOTCRETE WORK TO PROJECT

Everyone involved took this project personally and the quality showed. The teamwork, from ownership to both shotcrete companies, could not have been better. Today, this is Rails Steakhouse's private room where Stathis and his staff cater private parties.

Working in this small, rectangular basement would have been extremely expensive and time-consuming. Without

Fig. 1: Entrance way into cave behind hidden door

Fig. 2: In-process bench lounge room, being stained

Fig. 3: Dining room cleaned up after staining

shotcrete, this project would not have worked. Form-and-pour would not be possible to implement in this project from the space and time requirements, never mind the formwork and bracing that would have been required. The ability to free-form the concrete and carve it allowed Stathis to put his personal touch on the walls as we allowed the finishers to create and make the space look more realistic (Fig. 4 and 5).

The shotcrete application at this site was minimally invasive because it was completed in 1 day when the restaurant was closed. It was successful due to close coordination and communication, with teamwork being the key ingredient. If this was formed, just getting forms in would have taken days to setup for concrete. The shotcrete advantage offered the ease of a 2 in. (50 mm) line through the hallways. Concrete delivery and pumping to the shotcrete nozzle was done directly from the restaurant parking lot down a few stairways

2017 HONORABLE MENTION

Project Name
Rails Steakhouse Wine Cave

Project Location
Towaco, NJ

Shotcrete Contractor
Superior Gunite* and Eastco Shotcrete, LLC*

General Contractor
Rails Steakhouse

Architect/Engineer
Jim Stathis

Material Supplier/Manufacturer
Eastern Materials

Equipment Manufacturer
Western Shotcrete Equipment*

Project Owner
Jim Stathis

***Corporate Member of the American Shotcrete Association**

Fig. 4: Dining room set for a party

Fig. 5: Dining room into lounge

and a long hallway. Space was at a premium as there were several finishers working, the nozzleman and tender, as well as rebound cleanup crew.

Owner Jim Stathis remarked, "I am ecstatic about the finished product, this space would not be the same if it was not for the expertise of Frank Townsend and Tommy Pirkle. I am indebted to you both! I would also like to thank Rob and Dean who worked by my side every day they were available—they are very creative, talented young men with bright futures…Cheers!"

***Frank Townsend** is the East Coast Region Manager for Superior Gunite. He received his degree in civil engineering from Worcester Polytechnic Institute, Worcester, MA, and his master's degree from the University of Missouri, Columbia, MO. Townsend comes from the U.S. Army Corps of Engineers and his diverse military background has led to him being deployed around the world. Townsend is an active member of ACI Committee 506, Shotcreting, and a former Board member of ASA. He has been Awarded the U.S. Army Corps of Engineers deFluery Medal and the Engineer News-Record New York's "Top 20 under 40" award for design and construction leaders in 2016.*

2017 Honorable Mention

The Albertus L. Meyers Bridge

By Jeffrey L. Zimmerman and Dennis Bittner

Fig. 1: November 2016—view of entire bridge after repairs were completed

The Albertus L. Meyers Bridge, also known as the 8th Street Bridge, is located in Allentown, PA. The bridge spans the Little Lehigh Creek and connects Allentown's Center City and South Side. The bridge has a total length of 1793 ft (547 m) and a width of 48.8 ft (14.9 m). The structure is a reinforced concrete open-spandrel arch bridge (Fig. 1). It was originally opened on November 17, 1913. At that time, the total construction costs were in excess of $500,000 and 29,500 yd^3 (22,600 m^3) of concrete were used. It was stated to be the largest concrete bridge in the world when it was first built (Fig. 2).

The structure was a toll bridge from its opening until the 1950s, when the toll was 5 cents per car. Until 1953, the bridge also supported trolley traffic (Fig. 3).

The Meyers Bridge had last undergone a rehabilitation project in 1973 and was again in need of major improvements. The owner, the Pennsylvania Department of Transportation (PennDOT), solicited bids for those improvements in 2014. IEW Construction Group of Hamilton, NJ, was the successful bidder as a general contractor. The $20.3 million project included replacing the bridge deck, constructing new alcoves, repairing bridge piers, and reconstructing roadway approaches. It also included installing new lighting, sidewalk, curbing, fencing, pavement markings, and signs.

Mar-Allen Concrete Products, Inc., of Ephrata, PA, was subcontracted by IEW to perform the pier repairs. The repairs were originally specified to be performed using form-and-pour concrete. Much of the work was overhead, at depths of 3 in. (75 mm) and 120 ft (37 m) in the air. There were areas where reinforcing bar was 2 in. (50 mm) or less from the surface. Upon consideration, Mar-Allen suggested

Fig. 2: January 1913 construction progress

Fig. 3: 1916 postcard of the bridge

using shotcrete, specifically the dry-mix process, in lieu of form-and-pour concrete to make these difficult repairs more efficient with equal or superior strength and durability. PennDOT District 5 agreed to use shotcrete on a trial basis for this project.

In addition to the everyday challenges presented by repairs of this nature, the bridge was added to the National Register of Historic Places in 1988. In keeping with historical requirements, constant coordination was required with the Pennsylvania Historic and Museum Commission and the City of Allentown Historic Commission. When repaired, the structure needed to look as it did at its original time of construction. One of the biggest concerns was matching the color of the repair material to the existing substrate. Additionally, PennDOT required a corrosion inhibitor be included in the repair material. Mar-Allen selected QUIKRETE to provide the material for the project. Quikrete Shotcrete MS with integral corrosion inhibitor and fibers was used. The material was colored at the point of manufacture to match the existing substrate. The original color of the bridge was very light, and pigment alone could not lighten the material enough for a sufficient match. To obtain the proper color, white portland cement was used in the mixture.

Testing was stringent and frequent on this project. The PennDOT shotcrete specification required prequalification panels be gunned by each nozzleman on the project. Those panels were then tested for compressive strength as well as visually graded. Additionally, the prequalification panels were used to verify the color of the material. Ultimately, the Historic Commissions needed to approve the color and texture of the shotcrete. During the construction phase, test panels were gunned daily, again in accordance with the PennDOT's very stringent shotcrete specification. Those panels were cored, and compressive strength testing was performed. Additionally, multiple bond pulloff tests were performed on in-place material to test bond strength.

All shotcrete repairs were performed by Mar-Allen using ACI Certified Nozzlemen. The shotcrete portion of the contract began in July 2015 and completed in November 2016. The project required various and numerous repairs. Approximately 60% of the repairs were overhead. Repair areas were as high as 120 ft (37 m) off the ground. Many of the areas were complex shapes such as corners and arches (Fig. 4 and 5).

Unsound concrete was removed using chipping hammers. Repair depths ranged from 3 in. (75 mm) all the way up to 4 ft (1.2 m). Exposed reinforcing bar was cleaned by grit blasting and epoxy-coated reinforcing bar was used where replacement was necessary (Fig. 6).

Where supplemental reinforcement was required, galvanized mesh was installed. Shotcrete was then applied using the dry-mix process. All material was pre-dampened prior to application. To meet job requirements a final finish was placed on the material by qualified finishers to match the original finish of the structure. That finish also required approval by the Historic Commissions. Immediately after finishing, a spray cure was applied to help prevent plastic shrinkage

Fig. 4: Shotcrete in progress at a pier

Fig. 5: Shotcrete in progress at a spandrel column

Fig. 6: Spandrel column repair with chipping complete

Fig. 7: Looking through piers—shotcrete on an arch rib

cracking. A total of 32 truckloads of material in both 50 and 3000 lb (23 and 1400 kg) bags was installed on this project.

There were additional challenges on the project. The height of the bridge meant wind was a near-constant factor (Fig. 7). The wind and height, coupled with a limited area for placement, required some creativity. The adjacent properties and vehicles needed protection from dust, and the freshly placed shotcrete material needed protection from the wind. Large burlap curtains were sewn together and then hung from cables on the bridge (Fig. 8). This made it possible to open and close the curtains as needed. The height and openness of the structure provided limited shade, leaving much of the surface exposed to full sunlight. The curtains also provided some shade to help reduce the heat gain and drying effect of the sun.

All work was done in accordance with a Shotcrete Special Provision written for PennDOT by and with the collaboration of members from the American Shotcrete Association. While

Fig. 8: Burlap and reinforced poly curtains sewn together and hung from cables to protect cars and buildings from overspray

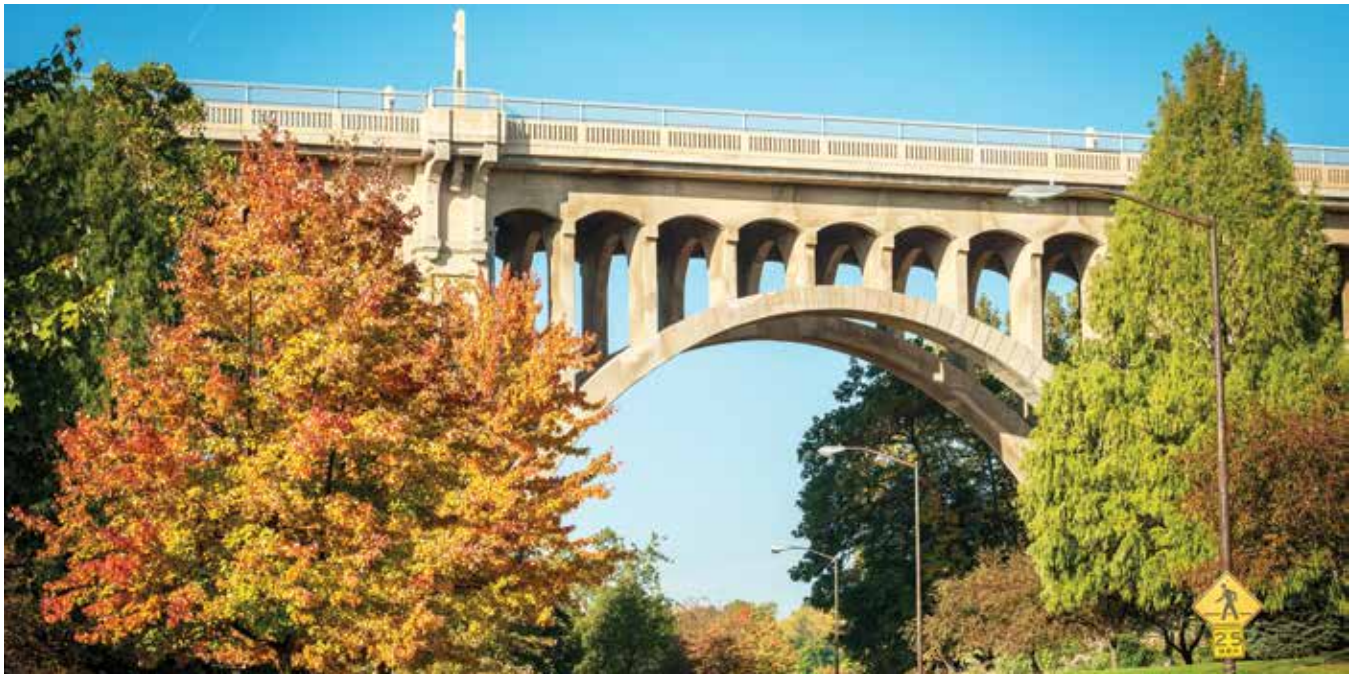


Fig. 9: November 2016—span over Martin Luther King Jr. Drive, all repairs complete

the Special Provision was officially added to PennDOT's Publication 408, Standard Construction Specifications, within the last few years, PennDOT started working with this provision nearly a decade before. The provision is extensive and covers any type of shotcrete application. It requires ACI Certified Nozzlemen, state-approved materials, pre-dampening of dry materials, and adherence to all applicable ACI guidelines. It ensures proper steps will be followed in the shotcrete process, resulting in a first-class finished project. The project was completed on time and to the satisfaction of the Historic Commissions and the owner (Fig. 9).

This was a project full of unique challenges. It serves as a great example of what can happen when the contractors, engineers, governing bodies, material supplier, and owner work as a team. The shotcrete method as suggested by the subcontractor saved the owner time and money. This is an excellent example of an owner and engineer embracing a methodology that was at the time unfamiliar to them, both should be commended. The repairs provided an aesthetically pleasing, strong, durable and low permeability repair that will protect the integrity of the structure for decades to come.

2017 HONORABLE MENTION

Project Name
The Albertus L. Myers Bridge

Project Location
Allentown, PA

Shotcrete Contractor
Mar-Allen Concrete Products, Inc.*

General Contractor
IEW Construction Group

Architect/Engineer
Michael Baker Jr. and Specialty Engineering, Inc.

Material Supplier/Manufacturer
The QUIKRETE Companies*

Equipment Manufacturer
Allentown-Putzmeister*

Project Owner
PA Department of Transportation (PennDOT)

*Corporate Member of the American Shotcrete Association

Jeffrey Zimmerman *has been involved in the shotcrete business for over 35 years. Throughout those years, Zimmerman has overseen many unique and challenging shotcrete projects. He was also a board member of ASA when it was in its infancy and has been a strong advocate in the northeastern United States for the shotcrete industry.*

Dennis Bittner *is the National Sales Manager–Infrastructure for The QUIKRETE Companies. He has been involved in both wet- and dry-mix process projects in multiple arenas of shotcrete construction, with an emphasis on bridge and tunnel projects for state departments of transportation (DOTs) and the rail industry. In addition to being an ASA member, Bittner sits on the ASA Board of Direction. He can be reached at dbittner@quikrete.com.*

2017 Carl E. Akeley Award

Akeley

Nitschke

The 12th annual Carl E. Akeley Award was presented to Axel Nitschke for his article, "Modeling of Load-Bearing Behavior of Fiber-Reinforced Concrete Tunnel Linings," published in *Shotcrete* magazine, Spring 2017. The article discussed the modeling process of load-bearing behavior based on the stress-strain relationship (SSR) for tunneling applications most commonly used. It also identifies the weakness of the current concept and suggests a path to more fully use the structural and economic potential of fiber-reinforced concrete (FRC). FRC can provide technical and economic advantages as the fibers transform the post-cracking behavior, typical of unreinforced concrete, from a brittle failure mode to an elasto-plastic behavior. The award was presented by ASA Publications Committee Chair Ted Sofis.

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.

Left to right: Lihe (John) Zhang, Axel Nitschke, Joe Hutter, and Ted Sofis

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 ASA President's Award


Hanskat

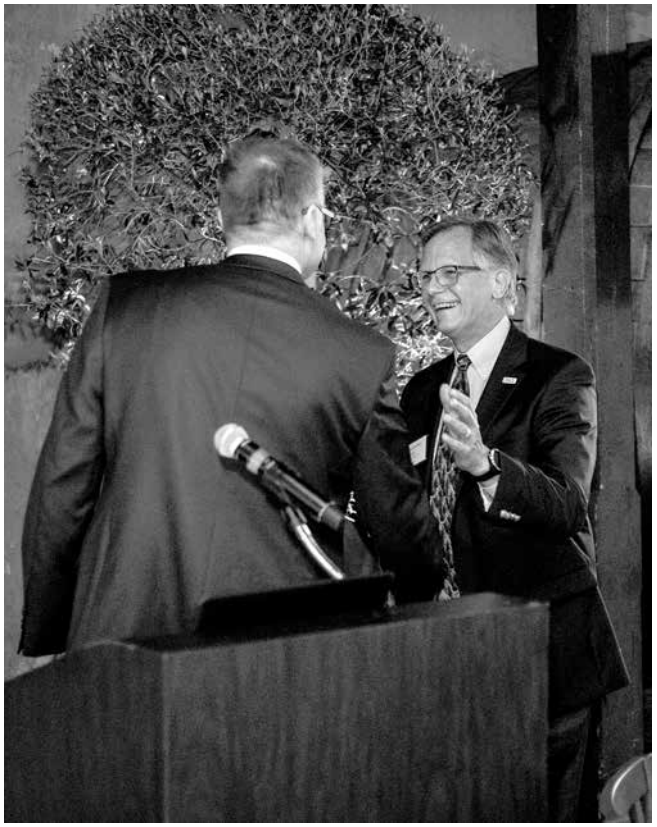
The ASA President's Award was established in 2005 to recognize the person or organization that has made exceptional contributions to the shotcrete industry. It is the sole responsibility of the current ASA President to select the recipient of this award. Since 2005, 11 well-deserving individuals and one organization have been awarded the ASA President's Award, all of whom dedicated their time and energy to advance the shotcrete industry.

Outgoing President Scott Rand presented the 2017 ASA President's Award to a truly surprised Charles Hanskat for his outstanding service not only to the Association but the entire shotcrete industry.

Hanskat, a professional engineer, earned his bachelor's and master's in civil engineering from the University of Florida, Gainesville, FL. Over his 40-year career, Hanskat has been involved in the design, construction, evaluation, and repair of environmental concrete, marine, building, and shotcrete structures. He is an active member of many ACI committees, a Board Member and Vice-Chair of ACI's Strategic Development Council (SDC), and Chair of the SDC Technology Transfer Advisory Group. Hanskat has been the President of ASA (2014), President of the Florida Engineering Society (FES), and a national director of the National Society of Professional Engineers. He is also a Fellow of both ACI and ASCE.

During his ASA presidency, Hanskat made one of his top priorities the initiation of a new strategic plan for the Association. The result was the development of four core principles: outreach, professional development, organizational strength, and credibility. The basis of this program continues to lead us today. Since his early involvement with ASA, Hanskat's ability to laisse with the numerous industry-level committees advancing strategic objectives with the best interest of the Association in mind, has been a clear separator.

Charles has worn many hats during his shotcrete career including those of a contractor, a consultant, an author, and an educator/examiner for certification. Added to the numerous committee and board-member level responsibilities mentioned earlier, it is apparent that his wealth of knowledge within the industry is hard to match. Hanskat's leadership and organizational skills are a tremendous benefit to our industry and Association. It is for those very reasons that Hanskat was not only a great choice for the Association's Executive and Technical Director, but also for this year's recipient of the ASA President's Award.



Getting the EDGE

By Jason Myers

As managers, we are always trying to find the latest management methods and secrets of the rich and powerful. But so often, we forget to review the tried and true methods that have been used for decades, even centuries. While developing this article, I was also planning a Boy Scout Summer Camp and a company safety meeting when I realized the similarities in the training, preparation, and activities for each of these events. One of the major training methods that scouting has been using since its start in 1910 is the EDGE method. It provides an easy-to-remember and highly effective way to teach any group, whether it is a group of scouts on an outdoor adventure or a group of construction laborers who are learning about the latest OSHA silica regulations. The EDGE method provides a four-step process of Explaining, Demonstrating, Guiding, and Enabling.

Each of these steps are part of our normal job activities but especially while teaching. I believe one thing we all do is focus on the early steps of the list and spend less time on the later steps, or even skip the later steps altogether. However, the power of the EDGE method is in the later steps. In today's litigious society, with increasingly complex issues, the later steps become essential. For example, if you are dealing with an OSHA inspection, they will not just ask if your crew has been educated about a certain topic but will look for demonstrated proof. With the EDGE method, you will have proof that they have been educated in the topic, have demonstrated the knowledge, and positively establish their knowledge basis.

EXPLAINING HOW IT IS DONE

This is the part of the training process that we spend the most time on and that takes the most effort. This includes time figuring out the information that needs to be presented, coming up with ways to explain that information in a clear and concise manner, and then getting the communication aids together (PowerPoint presentations, handouts, samples, etc.). There is a tremendous amount of time spent on this necessary activity, so it is important to clearly identify the critical training items up front so time is not wasted on nonessentials.

DEMONSTRATING THE STEPS

At one of the Boy Scout meetings, we had a training time where several of the older scouts taught the younger scouts how to tie knots. During the training, the older scouts used the Scout Handbook to show the proper steps but did not demonstrate themselves with actual rope, while the younger scouts did practice with actual ropes. After the training session, we had a relay race with various teams tying the knots they had just learned at each of the stations. To the embarrassment of the older scouts, they were soundly defeated by the younger scouts in the relay. There was even one older scout that had to confess that he did not know how to tie one of the knots he had just taught. This proves that just because you have the "book knowledge," it does not always mean that you have the head wisdom or hands-on knowledge. After training, it is important to have some way to physically demonstrate the knowledge or to be able to explain it in a different scenario, whether this is putting on a respirator after a respirator training class or tying knots in a fall protection class. Everyone learns in different ways and this provides a time for visual learners to see how something is done. The demonstration process can be used very effectively to enhance the explaining process, and often resulting in less overall time to reach a given level of knowledge.

GUIDING THE LEARNERS TO PRACTICE

I have been snow camping with Boy Scouts for the past 2 years at the base of Mt. Lassen in Northern California. Each year, the troop had a goal to build an igloo to sleep in (still waiting for our first success). Each year, the scouts have had the training to build the igloo and have demonstrated the steps before going out to try and do it, but not until you are actually building it—to practically demonstrate your knowledge—do you really find out if you know what you thought you knew. When you are faced with over 10 ft (3 m) of snow, temperatures that you can count on your fingers, and you desperately need to build a shelter, you find out if the knowledge you learned will save you.

So often when training is done, we perform the steps that need to occur and we can show how it is done, but not until the students demonstrate that knowledge do we find out if they fully understand it. This can be done in several different ways. One of them is by testing their knowledge through a written test. The advantage of a written test is it provides a document demonstrating their knowledge and the test can be tailor-made for the topic.

There are a couple safety items that my company must train our crews for with the local power company. For these training items, I have created specific questions of how shotcrete works within their safety program. Rather than the typical general questions that deal with issues my crew will never see, I am focusing on actual situations and

applications that they will deal with. Another way to facilitate practical retention is having them demonstrate it. A person understands so much more of how to do an action when they can do it in a safe environment. Whether this includes repelling off a building after a fall protection class or putting out an actual fire with a fire extinguisher, it is essential to demonstrate what you have learned.

While this step is often shortened or overlooked, I believe it is the most important step. In today's litigious mindset and document-crazy society, it is no longer safe to just issue a training card to an employee after they have been trained. All of us have been questioned about what topics have been covered and how do we know that the trainee understands the knowledge that has been given to them. By testing or having them demonstrate the training, it provides an additional essential step to make sure that there is full comprehension of the knowledge given. Today's construction workforce is multilingual with many of our workers not having English as a primary language. Thus, some form of testing or demonstration is essential to know the issues being presented are getting past the language barrier.

ENABLING THEM TO SUCCEED

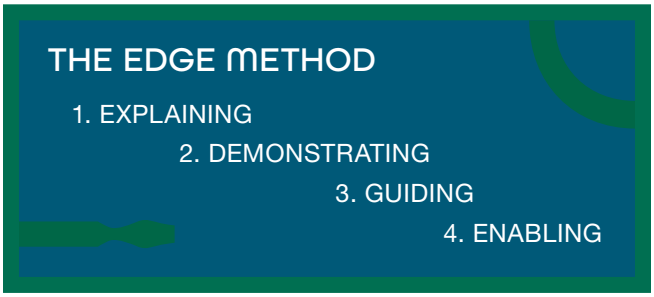
Through training, demonstrating, and guiding, the final critical step is enabling them to succeed. By performing all the previous steps, the trainees have been exposed to the knowledge, observed the knowledge in action, and shown they understand the knowledge. We often joke around in scouting that there is never a successful activity unless there is some sort of badge awarded at the end of the event. In a way, this is true for all trainees. Part of enabling them to succeed is the documentation that acknowledges they have been trained. By providing proof of training, it further motivates them to perform the tasks required.

One of my Assistant Scoutmasters works for a major pharmaceutical company in the Bay Area of California and was placed in charge of a division of the company that was not doing well and being considered for shut down. He decided to employ the EDGE method with his team by:

- Explaining—educating the team on how things are done with the correct procedures and documentation;
- Demonstrating—setting exact standards and expectations of how the operations are to be performed;
- Guiding—having them demonstrate that they understand the required procedures and processes; and
- Enabling—allowing the team to perform only according to the specified standards and procedures.

As a result, the division made a major turn around and instead of having to micromanage his team, he has stepped back. His team members now perform the work more efficiently and to a higher standard with fewer errors, because the expectations, standards, and procedures have been standardized.

The EDGE method is a highly effective and adaptive management training tool. It has been well proven over time and in many different circumstances—from life and death situations to teaching the latest techniques and methods.



The EDGE method is a salute to past successes for training workers and leaders of the future. So often we focus on the latest idea or the newest book when we should also be examining what has worked in the past and proven with time. The EDGE method exemplifies the old verse, "there is nothing new under the sun."

Jason Myers *graduated from California Polytechnic University, San Luis Obispo, CA, in 1995 with his Bachelor's in civil engineering and from Golden Gate University, San Francisco, CA, in 2015 with his Master's in business administration with an emphasis in project management. Myers started out 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. Myers joined Dees Hennessey in 2004 and has been a part owner of the company since 2007. He currently serves as the Vice President of Operations as well as the Safety Director.*

ABC POLYMER PUBLISHES BULK BAGS LIFTING GUIDELINES

Lifting and transporting bulk bags is a serious undertaking that should always be done with the full knowledge of proper, safe methods based on the specific bag, contents, and equipment being used. Thus, the Flexible Intermediate Bulk Container Association (FIBCA) has developed the FIBC Safe Handling Guidelines. Considering the importance of this issue to our industry, we are highlighting some of the most common precautions to be taken when any bulk bag is lifted.

Most of the safe handling procedures for moving bulk bags with a forklift truck also apply to using a crane or hoist. When using a forklift, crane, or hoist, always ensure that:

- The equipment has a rated capacity sufficient to support the filled FIBC;
- The forklift tines or crane hooks or bars do not have sharp edges or protrusions. Tines, hooks, or bars must be of adequate size with rounded edges at least the thickness of the lift loops or sleeves used to support the bag;
- All lift loops or sleeves are vertical without any twists, overlaps, or knots to prevent damaging them;
- The bag is suspended according to the manufacturer's instructions using all lift loops or sleeves provided;
- The bag is held close to the forklift's mast and as low as possible, with the mast tilted back at an appropriate angle. FIBCs should never be dragged or touched by forklift wheels;
- Any pallets used are of appropriate size and the bag does not overhang the sides; and
- The forklift driver or crane/hoist operator has a clear line of sight before moving the FIBC and all personnel are safely clear of the area.

"Lifting a bulk bag by fewer than the full number of lift loops or sleeves it was designed for can place undue stress on the bag material, causing damage and possible failure, while making the load unstable and potentially hazardous to personnel." – ABC Polymer Bag Experts

KNOWLES CONFIRMS AIR ENTRAINMENT IN DRY-MIX SHOTCRETE

Knowles Industrial Services is proud to announce verification of significant levels of air entrainment for freezing-and-thawing durability in dry-mix shotcrete. While air-entrained ready mix concrete has been available in the industry since its introduction more than 80 years ago, the process of introducing supplemental entrained air to dry-mix shotcrete is a more recent development that Knowles has been closely following. As customer demand for freezing-and-thawing-resistant shotcrete has increased over recent years, the company saw an opportunity to expand their client portfolio.

One of Knowles' key hydroelectric/utility clients recently requested a concrete application that could withstand the extreme winter weather cycles in New England. The owner and design engineer mandated a minimum of 4% total air entrainment by volume to resist damage caused by freezing-and-thawing cycles. Due to difficult site access requirements for conventional form-and-pour concrete application, this project was a strong candidate for dry-mix shotcrete. Knowles had never been tasked with adding additional air entraining to dry-mix shotcrete. The contract award was contingent upon successfully proving the ability to air-entrain dry-mix shotcrete prior to commencing construction.

Knowles has been following the use of admixtures for the dry-mix air entrainment concept for some time, as it affects their core business and is starting to take hold in the industry with meaningful data. Dry-mix shotcrete, by the nature of the process, typically contains up to 4% air. Dry mix has been documented to provide a very durable material up to 0.012 in. (0.25 mm) air spacing. To bring this technology to the project, Knowles produced a series of test panels at our Portland, ME, office on June 19, 2015, and had cores tested using ASTM C457, "Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete." They demonstrated outstanding air void system results with the proposed air-entraining admixture used for these tests.

For more information about Knowles Industrial Services and results of the air entrainment study, please visit **knowlesindustrial.com**.

QUIKRETE® LAUNCHES ONLINE QUIKCHAT TO BETTER SERVE CUSTOMERS

The QUIKRETE® Companies, the leading manufacturer of preblended commercial-grade concrete products, recently introduced QUIKChat, a live website customer engagement tool that provides real-time thorough response to inquiries. Accessible 24 hours a day, 7 days a week on **www.QUIKRETE.com**, QUIKChat connects customers with trained professionals, known as agents, who answer their specific product and project questions. According to the live-chat service provider, eight out of 10 customer inquiries are resolved during the initial interaction with an agent. "QUIKChat is designed to help our customers navigate challenges with projects

and products through personal interaction with a qualified expert," said Frank Owens, Vice President Marketing, The QUIKRETE Companies. "By delivering this one-on-one attention, customers are more comfortable and confident in the direction provided by our agents. That, along with the real-time nature of most QUIKChat conversations, helps us improve customer satisfaction, which is our ultimate goal."

QUIKChat is located at the bottom right-hand corner of every page on the QUIKRETE website, asking visitors if they have any questions. During local business hours, customers with questions simply click on the QUIKChat bar and enter their name and e-mail address to obtain assistance from an agent. During local non-business hours, customers can leave a message on QUIKChat and receive assistance when agents are back on duty. QUIKChat will also intuitively offer assistance to visitors navigating the QUIKRETE website for an extended period of time. Visitors who use QUIKChat are encouraged to share their experience as a training aid for the agents and to help improve the overall customer service moving forward.

The QUIKRETE Companies is the largest manufacturer of packaged concrete and cement mixtures in the United States and Canada, and an innovative leader in the commercial building and home improvement industries. QUIKRETE also offers related products through numerous wholly owned subsidiaries, including SPEC MIX®, Pavestone®, Custom Building Products®, Contech®, Rinker Materials, Target Technologies®, Daubois®, and QPR®. Collectively, The QUIKRETE Companies operates about 250 facilities in the United States, Canada, Puerto Rico, and South America, allowing for unsurpassed distribution and product depth. Technical centers across the QUIKRETE network also ensure that professionals and consumers alike are provided with the most innovative and highest-quality products available on the market. For more information on The QUIKRETE Companies or its products, visit **www.quikrete.com** or call (800) 282-5828.

WAGMAN HEAVY CIVIL, INC., AWARDED CONTRACT FOR RAPPAHANNOCK RIVER CROSSING

Wagman Heavy Civil, Inc., announces they've been awarded the design-build contract for the I-95 Southbound Rappahannock River Crossing project in Stafford County, VA.

The $101.6 million project, awarded by the Commonwealth Transportation Board, includes the design and construction for three new general-purpose lanes for I-95 south, as well as converting three existing lanes into collector-distributer lanes. The goal of the project is to reduce congestion and improve the safety and efficiency of traffic in the Fredericksburg area by providing local traffic with additional lanes of travel and replace aging structures.

A new bridge will be built over Route 17 and the Rappahannock River parallel to the existing I-95 southbound bridges to carry the new lanes. In addition, the bridges that carry I-95 north and south over Route 17, both of which have been deemed structurally deficient, will be replaced.

Greg Andricos, President and COO of Wagman Heavy Civil, states, "We have been pursuing this project with JMT for over a year and are elated to have the opportunity to work with our project team, our crews, and our partners at VDOT to make this project a reality and deliver positive transportation improvements to the people of Stafford County. We are ready to get started!"

Construction on the project begins this summer and is scheduled to be complete in 2022. For more information on the project, please visit the Virginia Department of Transportation website.

Wagman is a multi-faceted construction firm with major operations in heavy civil, general construction, and geotechnical construction services. Founded in 1902, Wagman is a fourth generation, family-owned company with offices in Pennsylvania and Virginia. As a heavy civil contractor, Wagman is a nationally recognized leader within the industry. Wagman's core competencies include: design-build, infrastructure, marine construction, modified concrete, grooving and grinding, and geotechnical construction services.

For more information about Wagman, please visit **www.wagman.com**.

ASA OFFICERS AND DIRECTORS ELECTED

Executive Committee

Left to right: Poole, Drakeley, Zhang, Rand, and Burkert

The ASA membership has elected the following individuals as officers in the Association, with terms beginning in 2018: President Lihe (John) Zhang, LZhang Consulting & Testing, Ltd; Vice President Cathy Burkert, American Concrete Restorations Inc.; Treasurer Ryan Poole, Consultant; and Secretary, William Drakeley, Jr., Drakeley Industries. They were all elected to 1-year terms. Scott Rand, King Shotcrete Solutions, will serve as Past President to complete the Executive Committee for 2018.

Board of Direction

Three individuals were elected to 3-year terms as ASA Directors, beginning 2018: Oscar Duckworth, Valley Concrete Services; Ryan Oakes, Revolution Gunite; and Bill Geers, Bekaert-Maccaferri Underground Solutions. These three new Directors join the previously elected Directors and the ASA Executive Committee to form the 14-member 2018 ASA Board of Direction.

ASA CELEBRATES

ASA celebrated its 20th anniversary and brought the shotcrete community together for an amazing schedule of industry-related technology classes and committee meetings during its First Shotcrete Convention and Technology Conference, kicked off of the Contractor Qualification Seminar, and capped off with the Outstanding Shotcrete Project Awards Banquet in stunning Napa, CA, March 11-13, 2018. Silverado Resort and Spa was the venue for the Convention and Conference, with the opportunity for guests to participate in golf, wine tours, bike tours, and other Silverado amenities. ASA welcomed guests from all over the globe, including Switzerland, Sweden, South Korea, and Peru, as well as Canada and the United States. ASA was greatly heartened to see the level of interest and participation in our first convention focused on shotcrete. ASA welcomes your feedback on this event and interest in future events.

The Thirteenth Annual Outstanding Shotcrete Project Awards Banquet was held at the nearby Inglenook Winery the evening of Tuesday, March 13. This is the first time we held our banquet away from the annual World of Concrete venue, but this gorgeous Francis Coppola Winery, set amidst 200 acres of vineyards, its own wine caves, and dining alongside turn-of-the-century 1000-gallon casks, proved to be a perfect venue to celebrate our 20th Anniversary and the awardees. We again celebrated an impressive slate of winners who presented their truly outstanding projects to a packed room of guests. In another first, ASA recognized not one, but two Outstanding Shotcrete Pool & Recreational Shotcrete winners—our first tie! This year we also unveiled a new award design that all winners received with great acclaim.

2017 OUTSTANDING SHOTCRETE PROJECT AWARD WINNERS

CATEGORY	PROJECT
Architecture | New Construction	Universal Volcano Bay
Infrastructure	Sound Transit Roosevelt Station (N150)
International	Regionally Symbolic Tunnel Portals at Expressways-South Korea
Pool & Recreational	Three-Tier Vanishing Edge Pool
Pool & Recreational	The Scheinberg Residence
Repair & Rehabilitation	Pier 57 Repair and Improvements
Underground	Liverpool Central Tunnel High Level Neck Repairs
Honorable Mention	Surf Ranch 2.0
Honorable Mention	Rails Steakhouse Wine Cave
Honorable Mention	Lake Country Wine Tunnels
Honorable Mention	Albertus L. Meyers Bridge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Thank You, Sponsors and Exhibitors

ASA is indebted to the many Gold and Silver sponsors who again broke all records for their generous contributions towards this event. Special recognition is extended to our sponsors who also exhibited, bringing a unique variety of products and services to the shotcrete industry! Both attendees and exhibitors enjoyed extended times of interaction as exhibits, meals, and breaks were located on the lovely Fairway Deck. Our first convention would not be such an amazing success without their strong support. A special thank you is also extended to all attendees who saw the benefits of a shotcrete-focused event and participated!

WORLD OF CONCRETE 2018

ASA, a co-sponsor of this annual showcase concrete event, again saw a steady stream of visitors stop by our booth in the South Hall. Great conversations and resources were exchanged as interest in shotcrete continues to grow with increased outreach efforts by ASA, resulting in stronger recognition and use of shotcrete in a wide variety of concrete projects.

ASA Board members Marcus von der Hofen and Frank Townsend presented a 90-minute seminar on "Advanced Shotcrete: Innovative Techniques for Architectural & Structural Projects." The seminar received strong reviews, and von der Hofen and Townsend look forward to presenting an updated version next year as well! Oscar Duckworth presented ASA's Nozzlemen Education class to an attentive group of nozzleman and others interested in learning more about shotcrete. Many of the nozzlemen then participated in the ACI Wet-Mix certification class hosted by Hydro-Arch in nearby Henderson, NV, later that week. Next year, we look forward to presenting the Nozzleman Education in BOTH English and Spanish classes! Stay tuned for more information.

2017-2018 ASA GRADUATE SCHOLARSHIP AWARDED

Blouin-Dallaire

The 2017-2018 ASA Graduate Scholarship has been awarded to Émile Blouin-Dallaire, Ing. Jr. 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 program was recently revised by the Board to provide the 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.

IN MEMORIAM

George D. Yoggy
October 16, 1937 – March 27, 2018

With a heavy heart, we announce George Davis Yoggy, 80, passed away on Tuesday, March 27, 2018. He is survived by his wife of 59 years, Anne; his children Kimberly, Lynn, and Kirk; and eight grandchildren. Born in Morris, PA, he grew up in Johnson City, NY; attended Wheaton College, Wheaton, IL; and was a member of the Naval Reserve as a Seabee.

Yoggy was a recognized leader in the shotcrete and underground construction industry, including serving as President of the American Underground-Construction Association (now UCA) and founding member of the American Shotcrete Association (ASA). George was a frequent speaker and author in *Shotcrete* magazine.

A college construction job in 1956 set Yoggy's career path. The contractor he worked for had a shotcrete division and he learned about the process on the job. Eventually, Yoggy became the Eastern Division Manager for the contractor's equipment manufacturing division, but in 1968, he struck out on his own.

He owned and operated Concrete Equipment Corp. and Shotcrete Plus Inc., a business engaged in the design, manufacture, and supply of equipment for ground support, shotcreting, and concrete placing systems in the North American tunneling, repair, and mining industry. In 1986, the company was acquired by Master Builders Inc., and he established the Underground Construction group for MBT Americas. Following his retirement from Master Builders, Yoggy continued working in the industry as a consultant and remained active in associations and conferences.

George's work took him across the United States and around the world. Some of his projects include the New York Water Tunnel, Mt. Lebanon, and the Lehigh and Cumberland Gap Tunnels. In addition to UCA and ASA, Yoggy was involved in the International Tunneling Association, American Concrete Institute, and ASTM International. He also served on the editorial advisory board of *Tunnel Business Magazine* from 2001 to 2013.

As one of the founding members of ASA, George had a huge impact on ASA, the shotcrete industry and, indeed, many of our members and their involvement with shotcrete. He was always willing to share his knowledge and experience with shotcrete and was a mentor to several of our members as they developed in their careers. George's involvement with the nascent ASA/ACI Shotcrete Nozzleman Certification program in 1999 helped to assure the program was off to a great start.

George stands as a giant in the shotcrete world, and especially with us at ASA. In the following, you will find several quotes from our members and George's acquaintances in the shotcrete business as they reflected on his passing. George will be missed but certainly not forgotten by those whose lives he touched.

"George was a giant in our industry and in our lives. We looked forward to meeting him wherever we went and seeing him bursting with optimism, sage advice, and cheerfulness."

"One of the few who does not need extra help with acceptance into the pearly gates. He will be missed."

"I consider knowing George for my short time a wonderful experience and always enjoyed his smile and helpfulness. He will be dearly missed by all he touched in and around our industry."

"The industry has lost a great champion, friend, and mentor."

"A true colleague, friend, and mentor always with a smile and fantastic personality. The industry lost a legend and institutional knowledge that cannot be replaced."

"George was a legend in the tunneling and shotcrete industry, but more than that—he was a great person ready to help all with a smile."

Finally, the family requests that for those wishing to make contributions in memory of George Yoggy to make those to:

The Moles Scholarship Fund
50 Chestnut Ridge Rd, Suite 102, Montvale, NJ 07645

SHOTCRETE CALENDAR

JUNE 24-27, 2018	**ASTM International Committee C09, Concrete and Concrete Aggregates** Sheraton San Diego Hotel & Marina | San Diego, CA **www.astm.org**
SEPTEMBER 6-8, 2018	**Mining & Exploration International** Las Vegas Convention Center | Las Vegas, NV **www.miningexplorationinternational.com**
SEPTEMBER 10-12, 2018	**Breakthroughs in Tunneling Short Course** University of Denver | Denver, CO **www.tunnelingshortcourse.com**
OCTOBER 13, 2018	**ASA Fall 2018 Committee Meetings** Rio All-Suites Hotel & Casino | Las Vegas, NV **www.shotcrete.org**
OCTOBER 14-18, 2018	**The ACI Concrete Convention and Exposition** Theme: "Dream Big, Build Bigger" Rio All-Suites Hotel & Casino | Las Vegas, NV **www.concrete.org**
OCTOBER 31- NOVEMBER 2, 2018	**International Pool | Spa | Patio Expo** Conference: October 28-November 2, 2018 Mandalay Bay | Las Vegas, NV **www.poolspapatio.com**
NOVEMBER 1, 2018	**ASA Contractor Qualification Seminar** at International Pool | Spa | Patio Expo Mandalay Bay | Las Vegas, NV **www.shotcrete.org**
NOVEMBER 7-9, 2018	**2018 ICRI Fall Convention** Theme: "Resiliency Above & Beyond Concrete Restoration" Omaha Marriott Downtown at the Capitol District | Omaha, NE **www.icri.org**
DECEMBER 2-5, 2018	**ASTM International Committee C09, Concrete and Concrete Aggregates** Washington Hilton | Washington, DC **www.astm.org**
JANUARY 21, 2019	**ASA Meetings** at World of Concrete Las Vegas Convention Center | Las Vegas, NV **www.shotcrete.org**
JANUARY 22, 2019	**ASA Shotcrete Nozzleman Education** at World of Concrete English OR Spanish class | ACI Wet-Mix Certification available Las Vegas Convention Center | Las Vegas, NV **www.shotcrete.org/WOC**
JANUARY 22-25, 2019	**World of Concrete** Las Vegas Convention Center | Las Vegas, NV **www.worldofconcrete.com**
JANUARY 23, 2019	**ASA Contractor Qualification Seminar** at World of Concrete Las Vegas Convention Center | Las Vegas, NV **www.shotcrete.org/WOC**
WANT MORE INFORMATION?	**See a full list with active links to each event: visit www.shotcrete.org and click on the Calendar link under the News & Events tab.**

National Gunite

National Gunite offers a professionally engineered solution that restores the structural integrity of deteriorated pipe.

Their experienced personnel have rehabilitated pipe from 30 in. to 30 ft (750 mm to 9 m) in diameter. Because conventional excavation is not required, National Gunite can rehabilitate culverts and sewers at a fraction of the cost of installing new pipe, with little or no inconvenience to the general public. Their proprietary gunite (dry-mix shotcrete) mixture, enhanced with microsilica, regularly exceeds a 28-day compressive strength of 8000 psi (55 MPa).

Because every repair situation is unique, National Gunite will physically inspect every pipe they will rehabilitate, then analyze the condition and site information and recommend the most cost-effective structural repair.

National Gunite versus other trenchless processes:

- With the pneumatic, hand-applied dry-mix shotcrete process, National Gunite can easily adapt to any unusually shaped or deformed pipe.
- Because National Gunite can repair only the invert of pipe that is otherwise in good condition, they can save the customer a significant amount of material placement and unnecessary expense.
- National Gunite can spot-repair various failures such as separated joints, deteriorated concrete, missing bricks or stone, and voids or cavities caused by undermining of the pipe.
- National Gunite can include the structural repair or addition of headwalls, outfalls, and retaining walls with our pipeline restoration work.

Fig. 1: Culvert before rehabilitation

Fig. 2: Culvert after rehabilitation

Fig. 3: Shotcrete placement is ideal for complicated piping configurations

Fig. 4: Finished shotcreted culvert and headwall

Fig. 5: Shooting inside a culvert

- The shotcrete can be reinforced with any combination of wire fabric, steel reinforcing bars, and polypropylene fibers.
- National Gunite is not limited by any maximum size of pipe or thickness of repair.
- Shotcrete is the only rehabilitation method that has a proven history with more than a century of use.

National Gunite

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REED INTRODUCES A NEW FULLY SYNCHRONIZED CHEMICAL WET SHOTCRETE DOSING SYSTEM

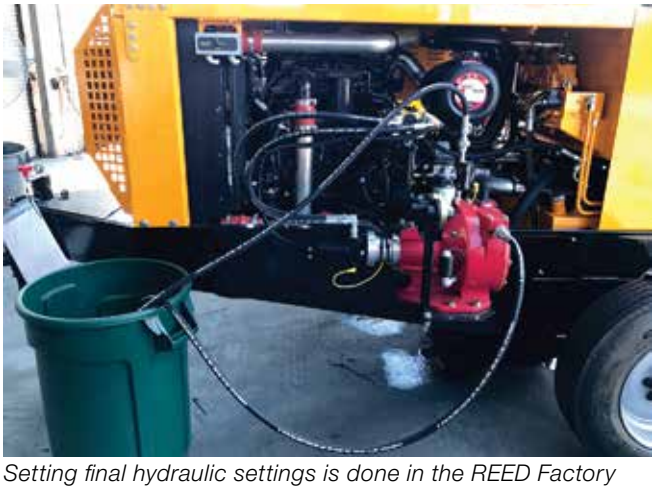
According to Duane Remus, REED's Director of Technical Development, "Our new chemical pump dosing system is driven hydraulically, eliminating the need for external AC power or cumbersome on-board DC-AC converters. It can also have very high torque while at very low chemical pump motor speed/displacement, facilitating the slow stroking needed sometimes when shotcreting. There is a closed-loop monitoring system to ensure chemical accuracy and that there is actual chemical in the line. When chemical is not present for a predetermined time, the entire pump system shuts off and an alarm sounds to ensure safety. Controls are onboard and viewable through the display of the controller and parameters are set through the input buttons. There are many settings that can be used to ensure correct dosage values. You also have the ability to go to the manual mode and prime the lines or clean lines."

Features of the Flowrox Model LPP-D0.5 Chemical Dosing Pump:

- Flowrox (out of Finland) makes the best chemical pumps on the market—they offer twice the horsepower capacity of models of the same capacity!
- Pressure! Like a REED pump, they have double the pressure—they can pump further at low RPMs, and will not have problems with inadequate torque.
- More than 360 degrees of contact by the compression lever translating to zero pulsation!
- The entire housing is steel, whereas there is a lot of plastic on other chemical pumps.
- Our PLC is taking information from two different sources simultaneously, and is making sure that the customer gets the correct volumes of chemicals per their specifications.
- Quick disconnect option is available should customers wish to put it away when not in use; it bolts on very quickly.

For more information, contact Mike Newcomb at mike.newcomb@reedmfg.com or visit **www.REEDpumps.com**.

Quick disconnect option is available should customers wish to put chemical pump away when not in use



Setting final hydraulic settings is done in the REED Factory Testing Department

PUTZMEISTER TO UNVEIL NEW CLASS OF TRUCK-MOUNTED CONCRETE BOOM PUMPS

Putzmeister America, Inc. (Putzmeister), will introduce its redesigned, optimized line of 30-meter (98 ft) class Truck-Mounted Concrete Boom Pumps in 2018. Each model shares a calm, sturdy pedestal with increased strength and a more robust structure, as well as new options packages for customization compared to the line's previous iterations.

"Across the board, these are to be among the most durable pieces of equipment in Putzmeister's history," said Dave Wright, Truck-Mounted Concrete Pump Product Manager for Putzmeister. "Not a thing has been overlooked with this 30-meter class. Everything is polished, thought out, and improved—from hydraulic and electric line routings to pedestal and boom designs. We're building on the hallmarks of the well-received 47Z-Meter, which was introduced at World of Concrete 2017."

All units in the 30-meter class, which has been in development for 3 years, share a common pedestal. These units also feature the Ergonic® 2.0 control system and the same third-generation exclusive Putzmeister Free Flow Hydraulics

that are already standard on many of the company's boom pumps. However, a point of differentiation exists with the smaller boom sizes, which have a smaller overall outrigger span, which equates to smaller front and rear outriggers as well as a shorter deck.

Every model in the 30-meter class features improvements based on customer feedback. For instance, the outrigger cylinder hydraulic line—which was previously welded—is now a bolted connection for easy maintenance and repair. Slewable rear deck steps increase access to the deck, and bottom steps fold up for travel to avoid damage. A decreased side profile, which reduces the overall height and makes for easier loading of pipe and hose on the side decks, is also standard. Additional features include a clean-out ball catcher added at the hopper outlet, and a standard auto lube to "A" hinge.

"Our extensive research, development, and field testing was very effective," Wright said. "There were multiple stages of technical assumptions, proven analysis, validation, destructive testing, and field testing. The engineering and R&D testing was slow and deliberate to ensure every aspect of each new model was evaluated. We took the time to get everything perfect."

Model-specific advancements were also made as necessary to improve performance. The 31Z-Meter features the same boom with a first section that was modified and lengthened to account for its offset head. Its pedestal is also new and more robust than its previous version.

Reinforced pedestals are also featured on the 36Z-Meter and on the recently introduced, well-liked five-section 38-Z Meter boom. The 36Z-Meter also includes a new boom design, which is a shortened version of the new 39Z boom.

The brand-new 39Z-Meter features an innovative boom design, robust pedestal design, and can be configured to meet virtually any pumping application. Although impressive durability was a priority, it has not come at the expense of excessive added weight—it remains lighter than Putzmeister's current, comparable 38Z-Meter.

"The 39Z is our jack-of-all-trades," Wright said. "With the BSA 39Z.13 HPD Multi, it is an all-in-one unit with detachable placing boom, BSA pump strength, and boom pump-level output combined. It's a super-customizable unit that's not been previously available in the market.

Three models in Putzmeister's 30-meter class maintain weights that are comparable to current models—even with the more robust pedestal. The common pedestal, which was design-tested to an extended lifespan, has been strengthened to better withstand torsion from the pump. It also includes thicker rear outrigger legs than previous versions; the front outrigger legs have longer section overlap for increased strength.

"The new 30-meter class is the result of 70 years' worth of man-hours and materials testing costs of more than $800,000," Wright said. "We can't wait for our customers to experience the difference."

For more information, call (800) 884-7210 or visit **www.PutzmeisterAmerica.com**.

SCHWING'S LONGEST BOOM—THE NEW S 65 SX

Schwing has added a new flagship model for 2018 and it is the longest boom in the company's line. The new S 65 SX incorporates a five-section boom, with all 5 in. (127 mm) pipeline for added benefits, while maintaining the versatility of their proven Overhead Roll and Fold design. In addition to providing 210 ft 8 in. (64.2 m) of vertical and 197 ft 6 in. (60.2 m) of horizontal reach, all 65 SXs come standard with Schwing's EASy one-sided outrigger system, minimizing the footprint of the pump for setup on crowded jobsites. The Super X telescopic front outrigger spread is balanced with rear slewing outriggers, which centers the hopper when set up in EASy configurations.

"Our customer advisory council had significant input into this design, and it was clear what they wanted: maximum reach in a five-section boom with 5-inch pipeline and a versatile outrigger system," states Tom O'Malley, Schwing Senior Vice-President of Sales and Marketing. The new model was displayed at World of Concrete 2018, held January 23-26 in Las Vegas, NV.

The new pump retains the popular twin-cylinder 2525H-6 120/85 MPS all-hydraulic concrete pump that has been refined with Symmetrical Switching. The innovation provides faster switching of the Rock Valve for smoother operation and less boom bounce. The S 65 SX comes standard with the Big Rock with extended housing for better filling efficiency of the 10 in. (254 mm) diameter material cylinders. An important benefit of the Schwing design is large-diameter, long-stroke pumping cylinders that provide high volume while operating with fewer strokes per minute for less wear. Output is 213 yd^3/h (163 m^3/h) with a maximum pressure on the concrete of 1169 psi (8 MPa).

"This is absolutely the most refined long boom in the world," adds O'Malley. "The number of pre-orders indicate demand to be high."

For more information, call (888) 724-9464 or visit **www.schwing.com**.

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