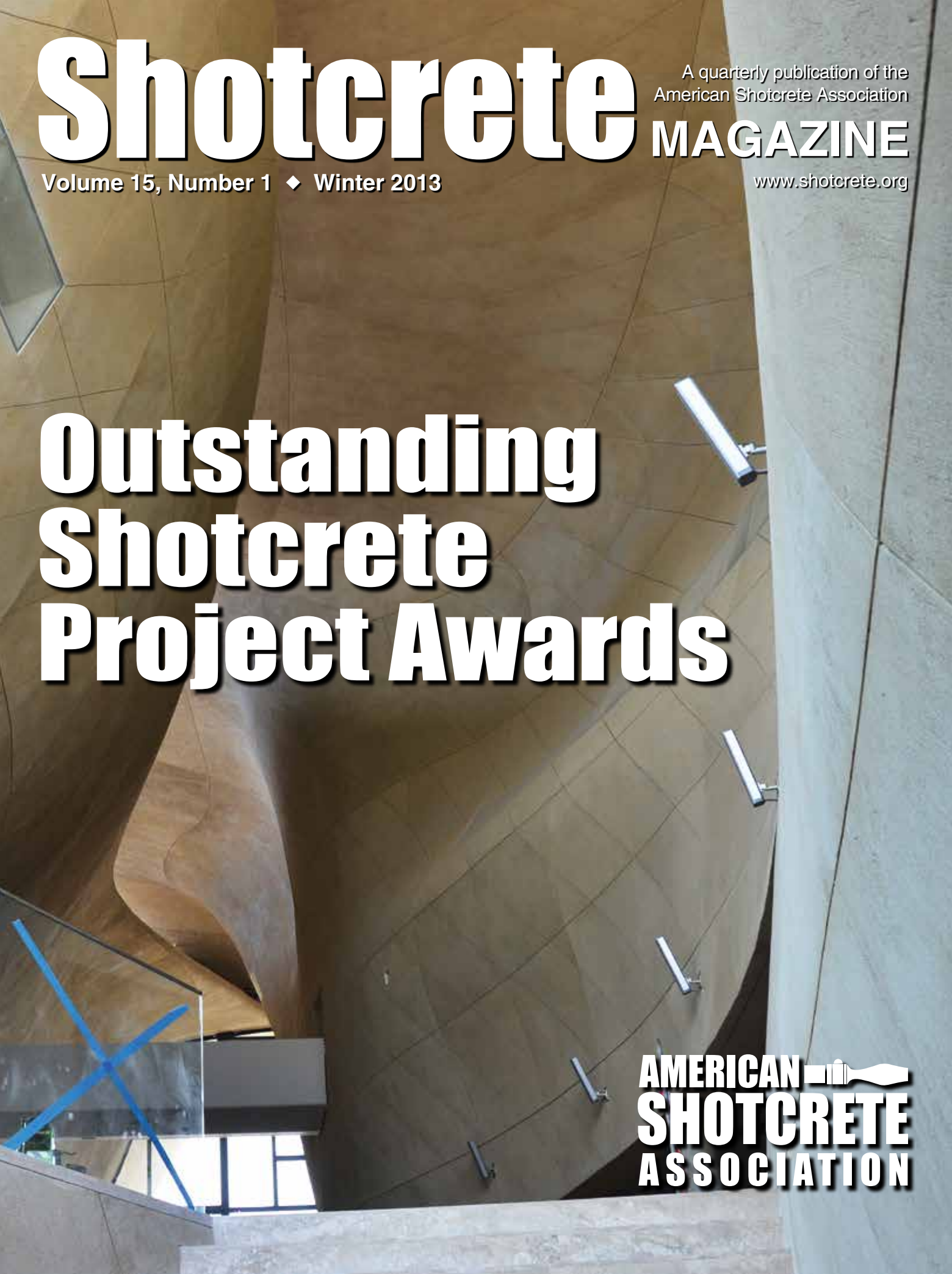
Shotcrete MAGAZINE
A quarterly publication of the American Shotcrete Association
Volume 15, Number 1 ◆ Winter 2013
www.shotcrete.org

Outstanding Shotcrete Project Awards



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Shotcrete MAGAZINE
Volume 15, Number 1
Winter 2013

Features

Departments

On the cover: The Museum of the History of Polish Jews, Warsaw, Poland
Photo courtesy of SPB Torkret

Looking Back...Looking Forward... 15 Years!

By Joe Hutter

As I sit down to draft my last President's Message, I can't help but think back to the inagural ASA meeting held 14 years ago at the ACI Fall 1998 Convention in Los Angeles and reflect on how much has changed in our organization since that initial meeting. Our initial membership consisted of 51 corporate members, all of whom were anxious to get involved and influence the direction that our industry would go. Those members were served by an Executive Committee, led by ASA President Lars Balck, that consisted of George Yoggy, Vice President; Rusty Morgan, Secretary; and Pete Tatnall, Treasurer. It was the hard work and persistence of that group that got ASA off the ground and built the momentum required to make our association the success that it is today.

This success can be measured in so many ways, but it is safe to say that the growth in corporate membership from 51 in the fall of 1998 to 165 today indicates that more companies are involved in the placement of shotcrete—whether they are contractors, equipment suppliers, material suppliers, or consulting engineers—and recognize ASA's influence within the shotcrete industry. Many of the members who participate, especially those who attend ASA meetings and serve on committees, task groups, the Board, or the Executive Committee, receive the added benefit of influencing not only the direction of our association but also the direction of our industry.

A prototypical example of this influence is the task group that developed the Nozzleman Certification program. This program was first developed by ASA volunteers, handed off to the American Concrete Institute (ACI), and later tweaked and modified to meet the changing needs of both our members and the industry. Today, the end result represents the hard work of so many ASA members who volunteer their time to improve the quality of shotcrete placed throughout North America and the world. The success of the Nozzleman Certification program is evident by the high number of specifications seen today that reference ACI Nozzleman Certification and by the fact that there are over 1300 ACI Certified Nozzlemen currently working on projects throughout North America. It is an accomplishment that our association can be proud of.

The next step in the journey to improve the quality of shotcrete placement is to address the topic of contractor prequalification. A task group, led by incoming ASA President Michael Cotter, is working hard to develop an ASA prequalification process that would identify ASA contractor members who have demonstrated their capabilities through a history of successful, high-quality shotcrete projects. This program would serve as a tool for specifiers to ensure that the contractors who bid on their projects are qualified to do so.

There are many other task groups that are working behind the scenes on behalf of the association and the industry to improve quality; educate specifiers; grow our market share; and attract new, young talent to our industry. The success—or lack thereof—of these task groups will be determined by the ASA members who get involved.

Finally, as our association heads into its 15th year, I would like to take this opportunity to thank all of the hardworking individuals who have supported ASA throughout my term as President and want to welcome Michael Cotter as he officially steps into the position in February 2013 at our ASA Awards Banquet in Las Vegas, NV. Many of us know Michael as a passionate, hardworking shotcrete contractor who has dedicated many hours to help better our association and our industry. If you are an ASA member, please step forward and offer Michael your support. There is no better way to influence the direction of our industry than to increase your involvement in our industry's association. If you are not a member, consider joining now. It's difficult to influence the outcome of a game when you're watching from the sidelines!

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ASA Underground Committee

By Dan Millette

This is an exciting time for the ASA Underground Committee, as this group is both undertaking new tasks and restructuring others, all designed to accomplish our mission to explore and promote underground issues within the shotcrete industry.

Hopefully you have noticed and are enjoying the new feature in *Shotcrete* magazine titled "Goin' Underground." This regular feature presents news and insights into the issues, challenges, and opportunities surrounding shotcrete in this very important market segment. ASA's Underground Committee works closely with the ASA Publications Committee at their regular meetings to identify issues of interest and secure expert authors to address them.

Another focus of the Underground Committee has been the implementation and promotion of ASA's underground education program for the mining and tunneling industries. To date, this program has not been successful in serving the underground industry. A recent review of the program by the committee noted the following insights. The ASA Underground Educational Modules are based on the same modules used in the ASA education program for ACI nozzleman certification. As a result, the current underground education program only deals with hand nozzling. Most mining and tunneling operations today, probably at least 80% in these industries, use some level of robotic or mechanical means of nozzle manipulation. Although much of the principles of shotcrete remain the same for both mechanical and hand applications, there is much missing in regards to the mechanical applications.

At the Underground Committee meeting in Toronto, ON, Canada, this fall, it was decided that the modules should be expanded to include robotic application methods. The committee has formed a task group to address the required additional information. The task group is Chaired by Lihe "John" Zhang and includes Georg Nickel, Raymond Schallom III, Patrick Bridger, and myself. Once this task group completes its work, the entire committee will work to update and revise a new ASA Underground Education program that will truly serve the shotcrete educational needs of the underground industry.

The ultimate goal of the ASA Underground Education Program is to serve the industry by delivering a strong resource that will supplement the training programs of underground-focused companies, as well as educational institutions, such as colleges and universities, which offer underground education courses.

About a year ago, the ASA Underground Committee meeting time was moved from a Tuesday evening time slot during ACI conventions to an earlier Saturday time slot to meet in conjunction with all of the other ASA committee meetings. As a result, the attendance at these meetings has increased significantly. Anyone with an interest in shotcrete and the underground industry is welcome to attend this biannual meeting, with the next meeting scheduled for Saturday, April 13, 2013, in Minneapolis, MN. I hope you will consider participating in this very important area of ASA.

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Transitions

By Mark A. Campo, ASA Executive Director

Let me take this opportunity to introduce myself as the new Executive Director of the American Shotcrete Association (ASA). In taking over for Chris Darnell, the previous ASA Executive Director, I find the Association to be in a very exciting position in terms of its stability, the diversity of its current offerings, and its potential for further growth.

Chris leaves the Association having recorded its highest-ever levels of both membership and certification activity; furthermore, many new or significantly updated programs have been released during his term as Executive Director. I plan to continue these successes and build many more along the way. I would also like to extend a sincere thank-you to Chris for his assistance in my transition into the Association, and I wish him the best of luck in his new endeavor.

For the last 7-1/2 years, I have been responsible for managing the technical content (examination materials, study guides, and related documentation) of new and existing ACI Certification programs at the American Concrete Institute. I served as liaison to its certification committees and managed its Quality Review program, as well as organized and executed other ad-hoc committee and task group projects. With an educational background in materials science and engineering (BSE, University of Michigan; MS, Northwestern University) providing the foundation of my concrete industry experience, I am eager to bring this unique skill set to the ASA staff in support of our ever-expanding technical and educational resources and certification programs.

Teamed with ASA's outstanding Programs Coordinator, Alice McComas, I'll work closely with our committees and volunteers in growing ASA and, as a result, strengthening the shotcrete industry as a whole. While getting to know many of ASA's members, I have found everybody in the shotcrete community to be extremely welcoming and it is clear that everyone involved is wholeheartedly committed to ASA's mission of encouraging and promoting the safest and most beneficial use of shotcrete. I look forward to meeting and working with you in the near future!

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2012 Outstanding International Project

The Museum of the History of Polish Jews

By Wlodzimierz Czajka

In 2012, SPB TORKRET Ltd completed a unique shotcrete project in Warsaw, Poland—an 85 ft (26 m) high wall with an approximate surface area of 65,000 ft^2 (6000 m^2). The wall was designed by Professor Rainer Mahlamäki. The three-dimensional (3-D), curvilinear wall symbolizes the Red Sea parting for the Hebrews' exodus from Egypt, and it forms the main spatial element for the interior of the Museum of the History of Polish Jews (MHPJ) (refer to Fig. 1 and 2).

Not that long ago, Poland was the center of the Jewish Diaspora and the home of the largest Jewish community in the world. Jewish settlements were established on Polish soil as early as the end of the 10th century. Jews came to call Poland their home. For centuries, Jewish cultural and religious traditions thrived. During the inter-war period, Poland was inhabited by 3 to 3.5 million Jews and had one of the biggest Jewish communities in Europe. In Warsaw alone, Polish Jews comprised almost one-third of the population.

Polish Jews were experiencing what some called another Golden Age. World War II brought tragedy upon the Jews of Poland. The Holocaust left the Polish Jewish community all but destroyed. After the war, remnants of a nearly extinguished Jewish presence in Poland still lingered. A renewal began and continues today. The ongoing rich, thousand-year history of Polish Jews and its impact on Poland today resulted in the decision to create an MHPJ in Warsaw, Poland.

In January 2005, the city of Warsaw, the Polish Ministry of Culture and National Heritage, and the Association of the Jewish Historical Institute of Poland signed an agreement establishing a joint cultural institution—the MHPJ. This historical event was made possible thanks to the voluntary involvement of many individuals and institutions. Among others, Aleksander Kwasniewski, the former President of Poland, offered his patronage over the Museum and Shimon Peres, the then-Prime Minister of Israel and current President, became the Chairman of the Museum's International Honorary Committee. On June 30, 2005, The Association of the Jewish Historical Institute

Fig. 1: "Waving" of the curvilinear wall

Fig. 2: "Dammed waves" of the walls in the lobby-hall area

Fig. 3: Fire protected wall substructure

of Poland published the results of the international architectural competition for the design of the building for the MHPJ.

This prestigious competition attracted famous architects from all over the world, including Daniel Liebeskind, Peter Eisenman, Zwi Hecker, Kengo Kuma, and David Chipperfield. Finnish architects Rainer Mahlamäki and Ilmar Lahdelma, of a Helsinki-based architectural studio, won the competition. In June 2009, a contract was signed between the owner—the Ministry of Culture and the city of Warsaw—and the main contractor—Polimex-Mostostal SA. Our company was subcontracted by the main contractor responsible for completion of the curvilinear wall.

Originally, the curvilinear walls were planned as resin-cement panels cast ex-situ and then incorporated into the steel curvilinear wall structure with the use of a system of holding elements. This technology of building a curvilinear wall was burdened with various implementation and economic problems. Knowing the possibilities of producing curvilinear surfaces with shotcrete technology, our company prepared three curvilinear wall models. At a meeting with the architect and representatives of the investor and main contractor, which was held at TORKRET's office in September 2010, a presentation of the wall execution method and the prepared models was made. After the visit, a positive opinion was given to the shotcrete application for building the curvilinear wall. Static load and fire resistance tests of the shotcrete model were required. A Poznan University of Technology team led by Professor Józef Jasiczak carried out static calculations and tested the load-bearing capacity of structural elements. The creator of the wall structure design and the detailed working design was Wlodzimierz Czajka.

The envelope of the curvilinear wall is a 2 in. (50 mm) thin-walled, reinforced concrete structure with mesh reinforcement (ø0.177 in. [4.5 mm] stainless steel ribbed bars). The wall is suspended using a system of anchors embedded in a substructure resting on steel columns. The steel columns forming the structure's framework are located in both walls of the hall and run along the entire building's height. Vertical elements are made of ø10.75 in. (273 mm) pipes, composed of sections, bent in one plane, horizontally braced, and formed into a grid by means of pipe profiles. Horizontal elements were made of ø4 in. (100 mm) pipes. The thin-walled, curvilinear dry-mix shotcrete wall is mounted through a system of rigid anchors to the pipes serving as the substructure.

The way stresses were distributed at the point of anchorage and dispersed in the wall surface section was an innovative approach. This distribution of stress was obtained by mounting a strap with radial bars onto the anchor. The solution allowed avoiding possible scratching and cracking of the wall at the points of contact with the substructure. For static calculation model purposes, the wall envelope was considered as multiple point-of-anchorage plates loaded with dead weight. By introducing expansion joints, dimensions of a single plate were limited to approximately 170 to 215 ft^2 (16 to 20 m^2). Each of

Fig. 4: The same element when finished

the wall elements underwent destructive testing, including a cut-out of the finished wall with the anchorage. The test of the wall's fire resistance was also crucial. It must be emphasized that the wall is not merely a decorative element or work of art but also a partition between walking routes for visitors and technical and office premises. The EI30 test was made on test elements in the Fire Testing Laboratory of the Building Research Institute, Warsaw (refer to Fig. 3 and 4).

Another innovative element was specially designed plastic strips embedded both in expansion joints and control joints. The structure of the plastic strips facilitated maintaining a constant shotcrete application layer thickness and delineated the outer surface. This also enabled installation of a membrane, preventing humidity loss and protection against dust when applying onto the adjacent element. The expansion joint strips were removed and replaced by fireproof silicone material. The control joint strips were left in the structure reflecting the so-called wall pattern assumed by the architect (refer to Fig. 5).

The most important issue from the wall profile shaping perspective was transferring the 3-D design coordinates to the wall modeling space. This was achieved by continuous layout of the points of crossing of joints or other typical points. Strips were mounted on a special plate serving as a stay-in-place form. The plate had to meet the elasticity (multi-directional bending) and non-flammability conditions. Once the plate with joint-defining strips was formed and fastened, two layers of concrete were applied. An Aliva 246 dry-mix shotcreting machine was used and pumps provided water to the nozzle. Dry-mix shotcrete was prepared internally at Torkret's custom mixing plant with a dedicated production unit designed specifically for the curvilinear wall construction. The first course was shot using a traditional shotcrete mixture based on rounded quartz aggregates and portland cement. The second phase was also made based on a selection of quartz aggregates, but the binding material was white cement with closely matched coloring. According to the designers' wish, the wall color was to reflect the color of rocks in Israel. The color was inspired by the color of the Western Wall in Jerusalem. This shade was obtained by mixing white cement and suitable dyes.

Maintaining a uniform color was one of the biggest challenges. Having experienced with similar applications, Torkret knew that different shades may occur on the resultant surface. Indeed different shades did occur, but they only added to the wall's special features.

Many execution-related issues were faced when building the project. A major part of the wall's surface area was made in the open space of the building. Installation of the roof covering and a glazed window (approximately 6500 ft^2 [600 m^2]) and the entrance structure weren't completed until the end of the project. This forced us to organize our work so that the preliminary stages were prepared during periods of lowered temperature while the application of shotcrete was conducted during advantageous weather conditions. A major execution-related problem was access to individual wall elements. Placement of a frame scaffolding that offered constant

Fig. 5: Mounting of strips–control joints

access would have been the best solution; however, we had to rule it out because wall layout required permanent geodetic survey of the spatial location of the wall. Light and heavy man-lifts and scissor lifts were used. To get access to the highest wall elements, a temporary platform was installed to which a crane track was mounted with a suspended scaffold. This wall access solution made setting-out, control, and verification of the shotcrete surface upon shooting much easier for the client (refer to Fig. 6).

The as-built tests referred to confirming of the assumed concrete class (minimum C30/37 as per PN-EN 14487-1, -2: 2007 Sprayed Concrete). The assumptions made concerning the substructure (rigidity), method of load carrying transfer from wall elements, and joint expansion width of 0.4 in. (10 mm) between the elements proved right. The wall scan made by the wall supervision company was compared to the design assumptions. The comparison proved we had achieved a unique precision of wall execution, expressed in millimeters of deviation (refer to Fig. 7 and 8).

Completion of the curvilinear wall took 13 months, which included basic structural work and several months of finishing work. All the emerging problems (performance-related, technical, and others) were solved on-site with our laboratory and Research & Development Unit during hours of meetings and practical tests. Finally, all wall work was completed in August 2012.

The exemplary cooperation of the architect, Professor Rainer Mahlamäki and his team, in solving the details, not to mention problems and conflicts that emerged, deserves credit.

Politicians from many different countries were interested in the construction of the MHPJ. Implementation of the project coincided with U.S. President Barack Obama's visit to Poland. President Obama paid homage to Jews at the Monument of the Warsaw Ghetto Heroes that is situated adjacent to the museum (refer to Fig. 9).

The unique combination of shotcrete application technology to form the wall's curvature and the selection of materials resulted in exceptional quality of the structure and a durability that exceeds the standard life span of a building.

Fig. 6: Execution of top part of the wall

Fig. 7: Entrance

Fig. 8: A curvilinear wall with glazing (western exposure)

Fig. 9: Museum originators, donors, Polish Minister of Culture, and Mayor of Warsaw with the American President in front of the museum under construction during President Obama's visit

Wall technical parameters:

a) Substructure

- Steel structure made of ø10.75 in. (273 mm) and ø4 in. (100 mm) pipes and reinforced concrete columns

b) Wall structure

- Thin-wall curvilinear double-sided, made of independent elements, separated with joints, of surface area approximately 215 ft^2 (20 m^2), reinforced with stainless steel bars
- Total surface area 65,500 ft^2 (6090 m^2)
- 2 in. (50 mm) thick at an area of 61,000 ft^2 (5700 m^2) and 6.30 in. (160 mm) thick at an area of 4200 ft^2 (390 m^2)
- Fastened to the substructure with ø0.94 in. (24 mm) anchors
- 85 ft (26 m) high
- External surface finished with unidirectional cut, color of light sandstone, approved pattern of joints
- Technology: structural dry-mix shotcrete and architectural through-dyed shotcrete.

Wlodzimierz Czajka *is the Technical Manager and a member of the Board of Directors of SPB TORKRET Ltd. From the beginning of his professional career, he has been interested in the shotcrete method. He gained extensive experience by working 13 years in a large construction company, where he led the Specialized Works Unit. In 1989, together with two partners, Czajka established TORKRET Company, specializing in repairs of reinforced concrete structures. For all these years, he has been a devoted promoter of the shotcrete method to designers and investors and has proactively participated in national and international symposia and conferences. He initiates innovative solutions that allow for implementing the shotcrete method on thin-walled structures in varying applications.*

2012 Outstanding International Project

Project Name
Museum of the History of Polish Jews

Project Location
Warsaw, Poland

Shotcrete Contractor
SPB Torkret LTD*

General Contractor
Polimex-Mostostal S.A.

Architect/Engineer
Professor Rainer Mahlamaki

Material Supplier/Manufacturer
SPB Torkret LTD*

Project Owner
City of Warsaw & Ministry of Culture and National Heritage

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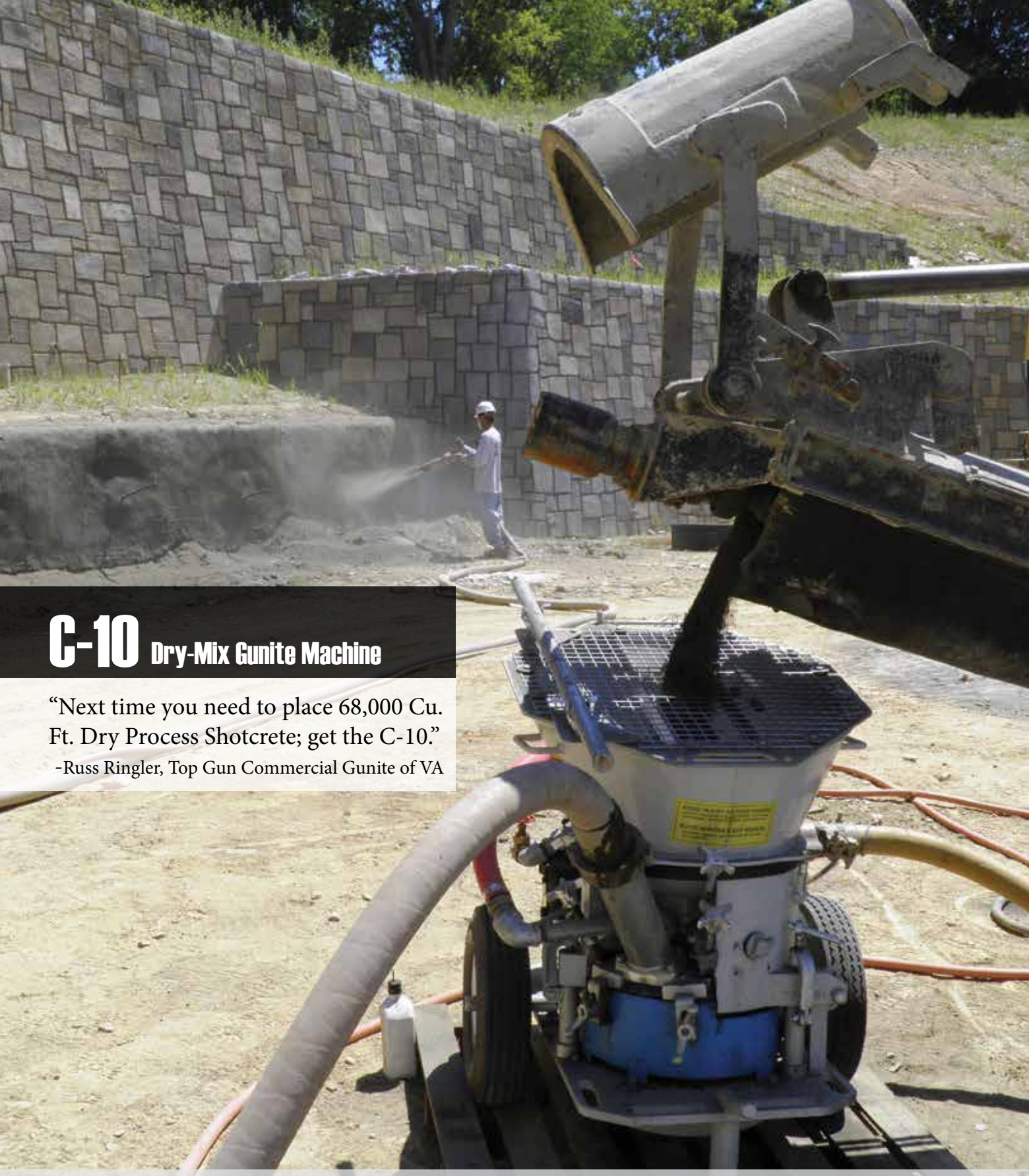

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2012 Outstanding Infrastructure Project

California Memorial Stadium

By Nur Kasdi and Larry Totten

Fig. 1: Overview of the existing historic walls during demolition and excavation. A layer of shotcrete was later applied over the existing walls in various thicknesses from 5 to 36 in. (127 to 914 mm)

Fig. 2: Type 1 preconstruction test panel was composed of three curtains of No. 10 (No. 32M) and No. 9 (No. 29M) reinforcing steel with additional boundary reinforcing bar elements

Since 1923, California (Cal) Memorial Stadium in Berkeley, CA, has been the home of the University of California (UC) Berkeley's football team. Modeled after the Roman engineering marvel of the Colosseum, the oval stadium is situated above the surrounding landscape on Berkeley's hillside and features panoramic views of the San Francisco Bay Area. Due to its age and historical significance, in November 2006, Cal Memorial Stadium was included on the National Register of Historic Places.[1]

While the stadium seemingly disregarded almost a century of time and remains in remarkable condition for its age, the seismicity risks in the area are a constant concern. Positioned directly on top of the active Hayward Earthquake Fault, which runs roughly from end zone to end zone, the stadium is subjected to annual horizontal fault "creep" of up to 0.20 in. (5 mm). During significant seismic events, the ground along the fault could displace up to 6 ft (1.82 m) horizontally and 2 ft (0.61 m) vertically—with potential catastrophic impacts on the structure.[2]

Cal Memorial Stadium was in critical need of not only a seismic retrofit but also an upgrade to modern standards. In late 2010, UC Berkeley responded by apportioning $321 million for the Memorial Stadium improvements, with work scheduled to start in January 2011. In preparation, the California Golden Bears football team was temporarily moved to the AT&T Park in San Francisco for the duration of the 2011 football season. The stadium reopened in fall 2012.

Work Scope

A unique feature to the project was that while the majority of the existing structure was demolished and reconstructed, the outer perimeter wall had to remain in place to preserve the historic landmark.

Johnson Western Gunite (JWG), a Superior Gunite Company, was assigned the task to install a heavily reinforced shotcrete layer over the historic wall for seismic strengthening. The shotcrete overlay varied in thicknesses from 5 to 36 in. (127 to 914 mm). Because the majority of the wall surfaces were exposed, a steel trowel finish

was required. The base contract volume was approximately 4000 yd^3 (3058 m^3).

In coordination with the concrete general contractor, JWG presented the owner with value engineering proposals for the majority of the new vertical cast-in-place concrete walls on the project. By substituting the cast-in-place method with the shotcrete method, the owner attained significant cost savings while maintaining both quality and project schedule activity durations.

As a result, the shotcrete scope doubled in volume through the addition of the following work: retaining walls, shear walls, miscellaneous interior walls, and a new loading dock building structure adjacent to the existing stadium.

Project Challenges

Like other shotcrete seismic retrofits, there were several challenges to the high-profile Cal Memorial Stadium retrofit project. First, because the project had a tight deadline schedule with a 6-day work week and double work shifts, the stadium was split into three work areas. Consequently, JWG had to coordinate multiple shotcrete crews working simultaneously in each area.

Second, the mixture design composition was especially unique for a Bay Area shotcrete project. After testing the concrete material, JWG had to make some modifications to customize it specifically for project application.

Third, the dense steel configuration in the shotcrete walls required close observation and quality control in the field. Preconstruction testing exemplified these congested areas to demonstrate that the nozzlemen were capable of performing the work.

Mixture Design Troubleshoot

The shotcrete mixture design was specified as a 7000 psi (48.3 MPa) mixture at 28 days. The original concrete mixture had a composition of 940 lb (426 kg) of cementitious materials with 15% fly ash content (equivalent to 10 sacks of cement) and 30 to 70% coarse-to-fine-aggregate ratio. The slump was 3.5 in. (89 mm). After analyzing laboratory trial results and conducting preconstruction testing, JWG adjusted the mixture design to tailor it to the work at the stadium.

When lab trial results proved that the mixture far surpassed the design strength, JWG was confident that the effects of a "hot mixture" could be reduced while still meeting the design strength. Thus, the cement content was reduced to 893 lb (405 kg), or 9.5 cement sacks.

During preconstruction testing, the JWG crew found difficulty in achieving the required steel trowel finish. As the finishers were "working" the substrate, the fine sand in the mixture kept emerging to the surface. This resulted in the surface exhibiting an aesthetically unpleasing "dimpling" finish. After investigating the issue, JWG determined that the root of the problem was the high content of fine sands. Subsequently, the mixture design was altered to include a blend of fine sands and fine aggregates, which increased the fineness modulus and created a more desirable aggregate gradation. Throughout the duration of the project, no further finishing issues were encountered.

Fig. 3: Cores retrieved from Type 1 preconstruction test panel

Fig. 4: Existing historic wall prior to shotcrete overlay application

Fig. 5: Application of 40 ft (12.2 m) tall shotcrete layer 36 in. (914 mm) thick over the existing historic perimeter wall

Fig. 6: Existing historic wall after shotcrete overlay application

Fig. 7: Shotcrete shear wall after the forms were stripped. The right side of the wall is the stripped form side. The left side is the shotcrete steel trowel finish side

Preconstruction Testing

Each nozzleman had to shoot a set of four preconstruction test panels that demonstrated the most challenging reinforcing steel configurations in the project. A mean grade of 2.0 was required to pass, with no single core having a core grade exceeding 3.0. Seven of the eight nozzlemen successfully passed the test. The engineer selected the following test panel conditions:

- Type 1: A historic wall shotcrete overlay intersected with a shear wall, with three curtains of No. 10 (No. 32M) and No. 9 (No. 29M) reinforcing steel with additional boundary reinforcing bar elements each 24 in. (610 mm) thick. Refer to Fig. 1 through 3.
- Type 2: A historic wall shotcrete overlay intersected with a shear wall with an existing pilaster obstruction and three curtains of No. 10 (No. 32M) and No. 9 (No. 29M) reinforcing steel with additional boundary reinforcing bar elements each 18 in. (457 mm) thick.
- Type 3: A historic wall shotcrete overlay with an embedded existing pilaster with reinforcing steel cages 20 in. (508 mm) thick.
- Type 4: A miscellaneous interior wall with an embedded column 12 in. (305 mm) thick.

Work Production

Shotcrete work occurred from May 2011 to February 2012 with a 6-day work week. As many as two to three shotcrete crews were on the job site each work day. The average pumping distance on the project was about 300 to 400 ft (91 to 122 m) from the shotcrete pump to the work location.

The dense steel configuration motivated the JWG crew to take an unconventional approach to shotcrete application. At some locations, the actual field measurements for the historic wall overlays were over 36 in. (914 mm) thick and required full height installation of up to 40 ft (12.2 m; refer to Fig. 4 through 6). To address this problem, shotcrete was applied in 12 ft (305 mm) tall lifts. Once the concrete material set up, the next shotcrete lift was installed. Consequently, there were no major voids as a result of poor consolidation reported on the project.

The walls were applied in one layer of scratch coat from the bottom to the top, and then the final finish coat from the top down was later applied (refer to Fig. 7). By taking this approach, JWG was able to ensure a uniform steel trowel finish. A unique experience at this project was that JWG found that the use of additional water-reducing admixture was actually detrimental to work production. As a result, JWG used a low dosage when applying a scratch finish so more concrete material could be stacked on the wall. The dosage was increased when applying the final coat finish, which accommodated extra time for the finishers to complete their work before the concrete set.

Summary

The California Memorial Stadium was undoubtedly one of the most unique seismic retrofit projects for JWG. The following were the keys for achieving this successful shotcrete project:

- Selection and modification of the high-strength concrete mixture design to streamline the shotcrete application process;
- Tight coordination in the field to stay on track with the fast-paced schedule; and
- Unconventional shotcrete application approach to deliver a high-quality shotcrete product.

References

1. "California Memorial Stadium," Cal Athletics, Berkeley, CA, 2010, http://stadium.berkeley.edu. (last accessed July 20, 2012)

2. Cardno, C. A., "Retrofit of Stadium Straddling Active Fault Moves Forward," *Civil Engineering*, ASCE, July 2010, pp. 12-14.

2012 Outstanding Infrastructure Project

Project Name
California Memorial Stadium

Project Location
Berkeley, CA

Shotcrete Contractor
Superior Gunite Company*

General Contractor
Webcor Concrete

Architect/Engineer
HNTB/Studios Architecture

Material Supplier/Manufacturer
Cemex

Project Owner
University of California, Berkeley

*Corporate Member of the American Shotcrete Association

Nur Kasdi *is currently the Project Engineer for Johnson Western Gunite, a Superior Gunite Company. Kasdi has been with the company since 2006 after receiving her BS in civil engineering from UC Berkeley. She provides estimating and technical support for various shotcrete projects across the United States. Her notable projects include the City Creek Center in Salt Lake City, UT; the Caldecott Fourth Bore Tunnel in Oakland, CA; and the SR 99 Tunnel in Seattle, WA. She is a licensed P.E. civil engineer in California and is a certified LEED Green Associate. Superior Gunite is a Corporate member of ASA.*

Larry Totten *is currently the COO of Superior Gunite Company and the President of Johnson Western Gunite Company. He has also served as a Project Manager and Chief Estimator in his 36 years with the company. He received his BS and MS in civil engineering and is a member of ASA, the American Society of Civil Engineers (ASCE), the American Concrete Institute (ACI), and the Associated General Contractors of America (AGC). He holds contractors' licenses in several states and is licensed professional engineer in California. He is current Chair of ACI Committee 506, Shotcreting; past Chair of the Northern California Laborers Trust Fund; a past Director and a Past President of ASA; and an Approved ASA Trainer for the ACI Shotcrete Nozzleman Certification Program.*

2012 Outstanding Repair & Rehabilitation Project

St. Paul Union Depot

By Richard Maxwell and Dave Sawyer

The St. Paul Union Depot, also known affectionately as SPUD, was originally built in 1881, at which time it became a landmark transportation facility in downtown St. Paul, MN. It served as a major Midwestern rail hub until its tragic destruction by fire in 1915. Construction of a new facility began in earnest soon after World War I and reached completion in 1923. At its height of operation in the 1920s, millions of pieces of mail moved through the depot annually; there were nine railroads operating within its walls, with an average daily train movement of close to 300.

The depot effectively ceased all transportation functions in 1971, when Amtrak moved its rail services elsewhere. The head house, a stark example of neoclassical architecture, was added to the National Register of Historic Places in 1974. Since that time, a number of businesses have occupied it, along with the U.S. Postal Service, which had been using it in conjunction with the neighboring Central Post Office.

But that all changed in 2011, when the Ramsey County Regional Railway Authority (RCRRA) approved plans to purchase the head house as part of a massive $250 million effort to return the trains to the depot.

Fig. 1: St. Paul Union Depot

Currently, a massive rehabilitation project is underway to restore SPUD (Fig. 1) to its historical glory, and RAM Construction Services, out of nearby Little Canada, MN, is playing a key part in the restoration.

According to Bryan Dziuban, RAM's Minnesota Regional Manager, the scope of work at SPUD involved some restoration of the carriageway and tunnels connecting it with the depot, but the bulk of the work took place in the southwest parking structure under the train deck (Fig. 2 to 5). The parking structure required over 30,000 ft^2 (2800 m^2) of removal and replacement of concrete. While the vast majority of delaminated concrete removal was achieved through hydrodemolition, RAM was responsible for hand-chipping those areas where the hydrodemolition apparatus was unable to reach.

From the outset, RAM's focus was on the mandate given by the RCRRA and the general contractor, Mortenson Construction (located in neighboring Minneapolis): restore the structural integrity to the historical landmark while remaining as true as possible to the original construction aesthetics.

But RAM didn't once consider a form-and-pour approach to this extensive challenge. As Jody Forsman, RAM's Restoration Field Superintendent, puts it, "The company prides itself on its knowledge of the materials and techniques that will yield the highest performance for any given application" and, as one of the largest shotcrete restoration contractors in the

Fig. 2: The majority of concrete removals were performed by hydrodemolition

Fig. 3: Smaller, isolated concrete repairs manually removed by a pneumatic jackhammer

Midwest United States, "we chose a dry-process shotcrete approach, using King Packaged Materials' MS-D1 Shotcrete."

In the case of the depot parking structure, RAM was adamant that the hydrodemolition get under way 2 to 3 weeks before shooting began. Even with its focus on quality workmanship, RAM still caught up to the hydrodemolition apparatus on two occasions.

Because the original parking structure, built in 1932, was formed and poured on wooden slats that were anywhere between 6 to 8 in. (152 to 203 mm) wide, the challenge for RAM was not only in replacing the concrete with the shotcrete


Fig. 4: Final stage of removals prior to shotcrete application

Fig. 5: Column prepared for shotcrete application

Fig. 6: Multiple layers of shotcrete prior to finish coat

Fig. 7: New shotcrete surface to resemble 1932-formed rough-cut plank finish

process but also in finishing it to emulate the original pattern left by the formwork used over 80 years before. To achieve this, RAM used a fabricated form board, which they pressed into the partially set concrete overhead, thus achieving an effect that imitated and blended in with the pattern left by the original formwork. This "historical touch" was very successful throughout the entire concrete replacement and included those areas that had been previously repaired but were not restored to the original pattern and aesthetic (Fig. 6 and 7).

With an average repair depth of 4 in. (102 mm), RAM used approximately 45 truckloads of King shotcrete for the project, amounting to approximately 500 yd^3 (380 m^3). As Richard Maxwell, RAM's Director of Operations, Restoration Division, puts it, "The key to a successful shotcrete repair lies exclusively with your crew, of whom the most important individual is your nozzleman." RAM uses the services of 15 ACI Certified Nozzlemen throughout their areas of operation. Having made shotcrete a core part of their restoration and rehabilitation division, they take the need to ensure that their personnel maintain certified status on an ongoing basis seriously. The SPUD parking structure rehabilitation required the services of four nozzlemen during RAM's original contract. Steve Spindler, Project Foreman for RAM, was responsible for 95% of the shotcrete required on this project. He has at least 20-plus years of experience as an ACI Certified Nozzleman.

SPUD was finished on time in September 2012. The extensive rehabilitation that RAM undertook to restore the underside of the train deck for the parking structure will significantly ease parking congestion around the depot. The entire structure will allow for an area of up to 250,000 ft^2 (23,226 m^2) devoted entirely to

parking. That bodes well for the future of this high-exposure facility that is expected to become the Grand Central Station of the Midwest. As a major hub for local light-rail transit, Metro transit buses, Greyhound and Jefferson buses, Central Corridor light rail, and the return of Amtrak, a fully rehabilitated parking structure takes on more importance than ever. In addition, thanks to the respect accorded past building practices, the historical SPUD can expect a bright future.

About the Company

Founded in 1918, RAM Construction Services is one of the oldest and most experienced waterproofing and restoration contractors in the United States. RAM Construction Services has built a solid reputation based on knowledge, experience, and reliability. Completing more than 2000 projects per year, RAM Construction Services has grown into one of the largest Midwestern contractors specializing in the restoration of aging structures and skilled waterproofing of new structures.

Over the years, RAM Construction Services has revitalized aging structures in dozens of states across the country. The projects range from below-grade waterproofing of a 600,000 ft^2 (55,742 m^2) auto assembly plant, to weatherproofing a 32-story office tower, to the delicate cleaning and restoration of stone and terra cotta on a 100-year-old church.

Corporate experience and the individual skill of superintendents and tradesmen are RAM's keys to a successful job. RAM Construction Services is available to advise clients on the methods most appropriate for cost and time savings. The best evidence of RAM's successful craftsmanship is the long list of repeat customers, owners, contractors, and construction managers who invite them to work on their projects.

2012 Outstanding Repair & Rehabilitation Project

Project Name
St. Paul Union Depot

Project Location
St. Paul, MN

Shotcrete Contractor
RAM Construction Services*

General Contractor
Mortenson Construction

Architect/Engineer
URS Corporation

Material Supplier/Manufacturer
King Packaged Materials Company*

Project Owner
Ramsey County Regional Railroad Authority

*Corporate Member of the American Shotcrete Association

***Richard Maxwell** has been a leader in concrete restoration for over 24 years. He specializes in parking decks, bridges, buildings, soil stabilization, and zoological exhibits throughout the Midwest, East Coast, and several southern states. In addition to shotcrete, Maxwell supervises other aspects of construction, including epoxy overlay, caulking, specialty deck coating, and post-tension repair for numerous types of concrete structures. He works directly with owners and owner representatives to consistently meet strict schedules and tight budgets. Hard work and dedication has advanced Maxwell to his present role as Director of Operations. In this capacity, he oversees all restoration projects for RAM's corporate office in Livonia, MI, as well as its three satellite offices located in Cleveland, OH; Cincinnati, OH; and Minneapolis, MN. Maxwell is highly involved with RAM's Safety Committee and is dedicated to promoting a safe working environment. He is an ASA member and has been involved with projects that received the International Concrete Repair Institute's Award for Excellence in 2000 and 2008, as well as ASA's Outstanding Shotcrete Project Award in Repair and Rehabilitation in 2007.*

(Editors note: We regret to announce the death of Mr. Maxwell on January 11, 2013 at the age of 46. ASA extends our sincere condolences to the Maxwell family and co-workers.)

***Dave Sawyer** is a Technical Representative with King Packaged Materials Company and is responsible for the sales and marketing of its line of shotcrete products in the southern Ontario, Canada, and U.S. Midwest markets. He has over 24 years of experience in the concrete industry and is a member of the American Concrete Institute (ACI) Toronto Chapter, ASA, and The Building and Concrete Restoration Association of Ontario.*

2012 Outstanding Underground Project

CSX Pinkerton Tunnel

By Dennis Bittner, Nick Laviolette, and Denis 'Dan' Laviolette

As part of the National Gateway Clearance Project, the Pinkerton Tunnel, located in Markleton, PA, was to be removed because it did not have the required height clearance to accommodate double-stack freight railroad cars. An excavation adjacent to the existing tunnel was planned to provide a new alignment for the railroad track. Pinkerton Tunnel, constructed in 1884, had an arch shape spanning over the track and was lined with stone masonry walls and brick arches. After starting the removal process, large pieces of the tunnel's brick liner began to loosen and some fell on the single railroad track that occupies the tunnel. In addition, large cracks were forming throughout the 1080 ft (329 m) tunnel, and the situation was deteriorating.

Because detouring freight and long-distance passenger trains running through this tunnel was not a viable alternative, it was decided that immediate interim repairs would be needed to keep this major artery for CSX Transportation open until the adjacent new alignment was completed.

LRL Construction Company was brought on board to perform these repairs. Nick Laviolette, their Project Manager, together with the tunnel design team employed by the railroad, developed a solution that involved adding structural support to the tunnel by shotcreting 8 in. (200 mm) thick continuous leg-arch-leg supporting ribs on 4 ft (1.2 m) centers within the tunnel. A 4 in. (100 mm) layer of shotcrete, with material supplied by Quikrete, was then placed between the ribs. With

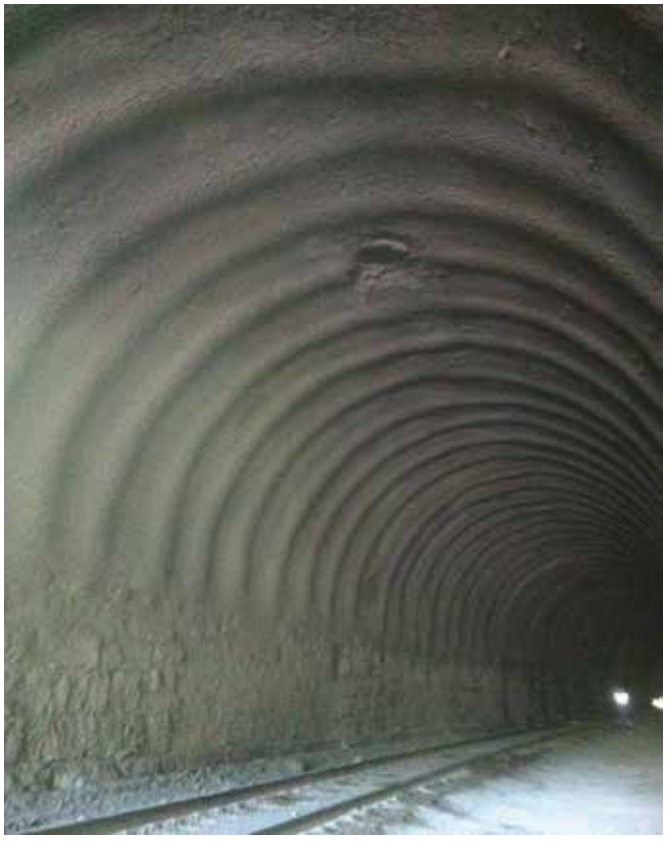

Fig. 1: Ribs 8 in. (203 mm) thick with 4 in. (102 mm) of shotcrete in between were placed

Fig. 2: Nozzlemen placed 100 bags of shotcrete a day, sometimes working on steep slopes

the additional structural support of the new shotcrete ribs, the existing brick liner was able to structurally bridge the area between the ribs. In addition to the time saved by using the rib solution versus using a more typical solution of a 12 in. (300 mm) thick layer of shotcrete over the entire liner, the quantity of shotcrete used was dramatically reduced (refer to Fig. 1 and 2).

The arch shape of the tunnel efficiently carries the external loads pushing on the outside of the tunnel by compressive stresses. This allows the arch to span a large open area and eliminates tensile forces across the arch and the potential for cracking caused by tension in the structure.

LRL Construction began the work by first removing (scaling) loose brick by hand so that a safe workplace could be provided. The scaling work then progressed with the workers always staying under the previously scaled areas. This technique minimized the risks associated with working under the loose areas of the original tunnel brick. Once the loose brick was removed, the contractor began applying shotcrete. At first, a uniform, thin coat of shotcrete was applied before starting the construction of the ribs. The tunnel, however, had a major seepage of ground water through the tunnel walls and when the shotcrete was applied uniformly, delamination occurred. LRL suggested that shotcreting be staged by first constructing the ribs and leaving the areas between ribs for groundwater to migrate through the brick lining. Once the ribs were complete, drain strips were installed in the areas between ribs. The drainage strips then diverted the flow of groundwater and allowed shotcrete to properly bond in the areas between the ribs. The construction management team and design management teams were pleased with the results obtained using these techniques (refer to Fig. 3).

The field-modified construction techniques succeeded, and the tunnel remained safely in service throughout construction. The tunnel's structural integrity was significantly improved with a solution that was extremely quick (2 to 3 days) to construct and readily adapted to the conditions encountered; allowed the adjacent excavation to continue; and, most important, provided a tunnel able to continue safe passage of approximately 30 trains per day for 6 months until trains were able to be placed on the adjacent new alignment.

In construction, 1177 super sacks of shotcrete, 25 steel sets with channel lagging, numerous split bolts, and many yards of drain strips were

Fig. 3: Manlifts used to access the arch roof for scaling, drainage placement, and shotcreting

Fig. 4: Work was performed 24 hours a day for 28 days

2012 Outstanding Underground Project

Project Name
CSX Pinkerton Tunnel

Project Location
Confluence, PA

Shotcrete Contractor
LRL Construction Co., Inc.

General Contractor
LRL Construction Co., Inc.

Architect/Engineer
Jacobs & Associates/Shannon & Wilson, Inc.

Material Supplier/Manufacturer
The Quikrete Companies*/
Shotcrete Technologies*

Project Owner
CSX Railroad

*Corporate Member of the
American Shotcrete Association

installed in 4 weeks with work progressing 24 hours a day for 28 days (refer to Fig. 4).

The shotcrete was provided by The Quikrete Companies. Additional equipment was provided by United/RSC Rentals. Steel sets and split bolts were supplied by DSI Steel. Drain strips were provided by CSI Geosynthetics. Construction support was provided by Fay Construction. The engineering companies involved were AMEC; Shannon & Wilson, Inc.; Jacobs & Associates; and TranSystems Hill Gateway.

Dennis Bittner *is a Construction Products Representative 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 Corporate member, Bittner sits on the Board of the ICRI Pittsburgh Chapter. He can be reached at dbittner@ quikrete.com.*

Nick Laviolette *is a Construction Project Manager and the son of one of the founding owners of LRL Construction Co., Inc. He has been involved with railroad tunnel repair, reconstruction, and clearance improvement projects for multiple rail line owners for 16 years. In addition to steel fiber-reinforced microsilica shotcrete placement as a tunnel liner, Laviolette has placed shotcrete by hand and using robotic nozzles for large-scale state DOT landslide repair projects and private slope stabilization projects. He has also placed shotcrete for mine shaft projects using the New Austrian method (NATAM).*

Denis 'Dan' Laviolette *is the sole owner of LRL Construction Co., Inc., and has over 38 years of tunneling experience. Laviolette started his company along with two business partners in 1996 and has since taken a small family-owned company into an empire. He takes pride in the specialized work that his company has come to master and is known for fast, safe results when needed most. His extensive knowledge and expertise in tunnel repair, shaft development, tunnel fires, and emergency collapse repair stems back to his mining days and have evolved over the years from working all over the world.*

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2012 Outstanding Pool & Recreational Project

Coastal Maine Negative-Edge Pool

By Mason Guarino

A coastal Maine home sat alone at the end of a long driveway with little to no property features other than the surrounding forest floor and an elevated view of the ocean. But that was slated to drastically change when the homeowners asked South Shore Gunite Pools & Spas, Inc., to work with their architect and builder to install a spectacular pool. The land had a natural slope to it and, with the ocean view, created an ideal venue for an architectural masterpiece. After some meticulous design and planning to incorporate the project into the natural Maine landscape, the pool concept was complete. The pool would have a negative edge toward the forest side and a beach entry on the house side. The pool design kept the water level with the pool coping and decking around the pool. The final product would have a very dark, natural look to it.

The difficult part was creating the drawings—detailing how to best build the pool to last in the harsh Maine climate with everything functioning correctly. Freezing winter temperatures required a significant foundation constructed with dry-mix shotcrete and clean, crushed stone. The complexity of the pool required it to be constructed in specific phases; the first phase included the negative-edge portion, followed in the second phase by the remainder of the pool (Fig. 1 to 3). The negative-edge feature, including the spillway wall and trough, needed to be constructed first to create a deep footing that would reach below the frost line. In the first mobilization, the trough area was excavated to the required depth and then over-excavated on the pool side to allow us room to construct forms. For the future, well-draining fill material was required under the pool. After excavation, extensive plumbing was installed, followed by form erection and placing of the pool shell reinforcing steel, and then shotcreted with dry-mix shotcrete. Some of the reinforcing steel in the trough wall extended out from the wall to allow for subsequent tie-in with the pool floor.

Next came the pool itself. After the trough and spillway wall were completed, the pool floor area was backfilled with free-draining crushed stone that would prevent any water buildup and potential heaving due to the freezing winter temperatures. Everything within 4 ft (1.2 m) of potential exposure to freezing air temperatures was filled with crushed stone or dry-mix shotcrete, as frost heave does not just affect horizontal sections of the pool but could also impact vertical sections that line the spillway. The pool had a shotcrete perimeter gutter that would later provide the overflow and

Fig. 1: Stone underlayment along with the reinforcing bars penetrating out of the first phase of construction so the second-phase pool section could be tied in correctly

Fig. 2: Elaborate reinforcing required by the pool design as we start the second phase of shotcrete

deck-level water capability. Two pockets on either side of the beach-entry area were constructed to hold natural rocks from the surrounding property to help the pool blend into the landscape. After initial curing and once the pool shotcrete reached the required strength, the boulders were installed. Shotcrete was placed around the boulders to secure them in place (Fig. 4).

The complexity of the pool structure created sections located from well below the frost line to right at and above the frost line. This required extensive structural design, resulting in a lot of reinforcement. The reinforcing steel consisted of two layers of No. 4 (No. 13M) reinforcing bar in the entire pool. The horizontal reinforcement spacing was 8 in. (203 mm) on center and vertical spacing was 6 in. (152 mm) on center. During shooting, a blowpipe was used extensively to keep the outer layer of reinforcing bar clean and prevent any rebound from building up on the bar surface, where it would reduce the quality of the in-place concrete. Overall, with the multiple phases, the shotcrete portion of the job was completed in 5 days.

The customer wanted to have the negative-edge wall act like an aggressive waterfall. Producing the waterfall effect required high flow rate demands that also affected water turnover. Based on the length of the perimeter overflow, the calculated flow rate required to create the waterfall effect was 740 gal./minute (350 L/s). This high flow was provided by a 10 hp pump outfitted with a variable-speed drive to allow for increased energy efficiency and control. The main feature plumbing lines were 8 in. (203 mm) polyvinyl chloride (PVC) to smoothly convey the substantial volume of water. With the high flow rates needed for the waterfall, conventional 2 in. (50 mm) pool returns produced too much turbulence for the vanishing-edge waterfall effect. Thus, additional main drain-type fittings were installed at the bottom of the pool to supply the high-flow-rate return water with minimal disturbance on the pool surface for the vanishing-edge waterfall. There were also multiple main drains for suction and additional drain-type fittings used as inlets. A buried precast concrete surge tank was also used to ensure that an adequate volume of water was available at all times. To blend with the natural Maine surroundings, the tiles and coping stones were custom-manufactured from an indigenous stone local to Maine. The majority of the stone was a dark gray with some white veins that fit in perfectly. We installed the coping stones on the shotcrete gutter so the inner stone allowed water to pass over it in a small slot between two rows of stone and then into the gutter. The pool was waterproofed before the final finish of black pebble was installed on the interior. In the rock pockets that would not be able to have a final finish, a more substantial waterproofing product was used.

On projects like this, South Shore Gunite prefers to use its Airplaco mobile batch plants. When we use Airplaco mobile batch plants, all the worrisome aspects when using ready mix are

Fig. 3: Deep excavation required for forming and, subsequently, filling with free-draining stone to prevent frost heave. Also seen is the dowel reinforcing bar that was tied into the pool floor in the second phase

Fig. 4: Completed shotcrete with large rocks placed

nonexistent. There is no waiting on trucks, worrying about a truck sitting too long and getting hot, or breakdowns leading to a costly wasted ready mix truck. In certain areas, especially remote locations in Maine, a ready mix truck would be close to an hour old when it first arrived on site, thus allowing insufficient time to use the load of concrete while the material is still in acceptable condition. Our mobile batch trucks have been outfitted with a hydraulic system that quietly powers the Gunite Supply C10 shotcrete guns. Compressed air was supplied by an Ingersoll Rand 825 CFM (390 L/s) truck-mounted air compressor. A six-man crew, including the truck driver/gun operator, is typical on a project like this.

The overall job took about 9 months to complete (Fig. 5 and 6). A lot of the construction was done in the winter under a tent that the general contractor erected over the swimming pool. This allowed the pool construction to be completed more quickly. All shotcrete work took place before the winter weather became an issue. The final product lived up to all of the expectations the homeowners were looking for and then some. This pool is definitely one of South Shore Gunite Pools & Spas' most intricate residential pools to date.

Fig. 5: Completed pool from the beach-entry end

Fig. 6: Completed pool from the negative-edge side

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

2012 Outstanding Pool & Recreational Project

Project Name
Coastal Maine Negative-Edge Pool

Project Location
Chelmsford, ME

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

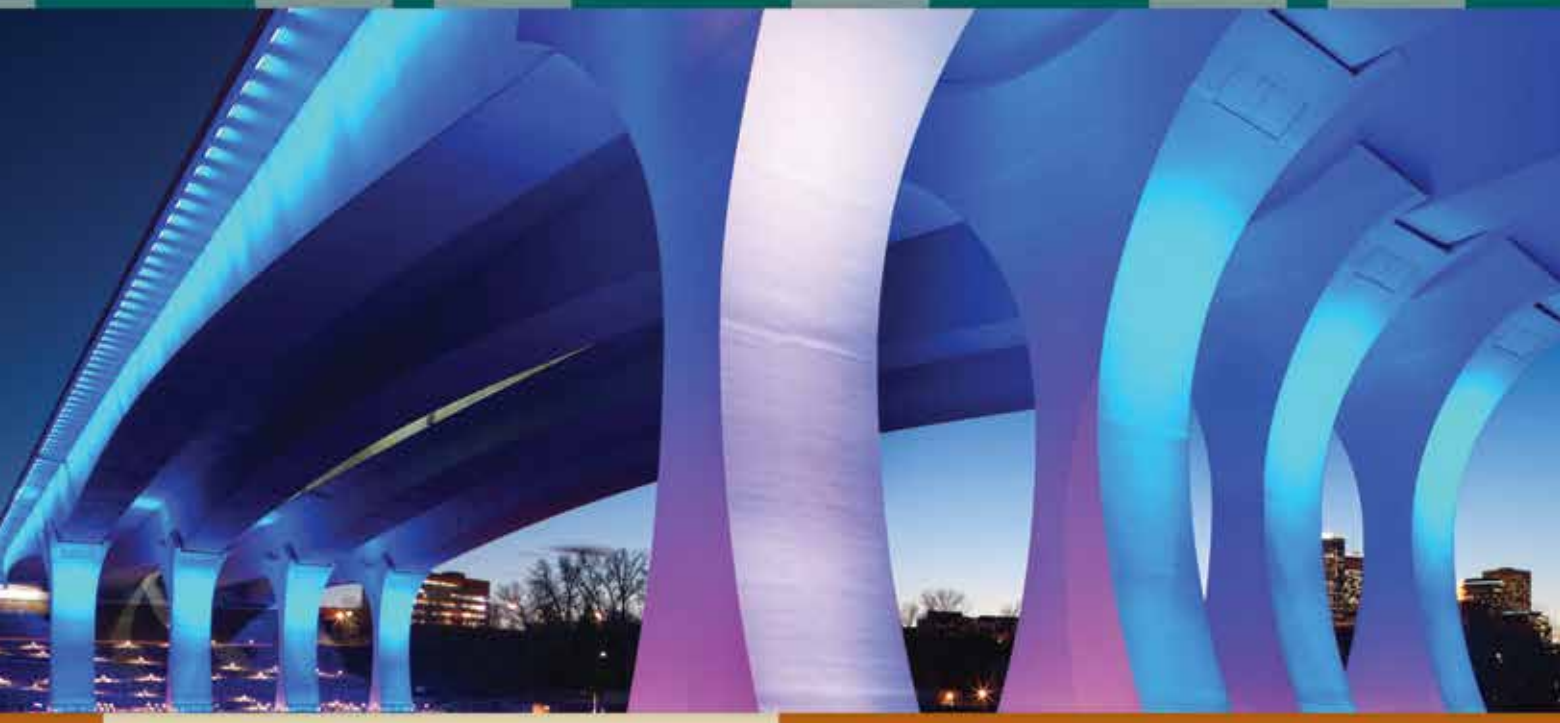
General Contractor
n/a

Architect/Engineer
n/a

Material Supplier/Manufacturer
Airplaco/Gunite Supply*

Project Owner
Name withheld

*Corporate Member of the American Shotcrete Association



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2012 Outstanding Architecture Project

VanDusen Botanical Gardens

By Gary Hawkins

Torrent Shotcrete Structures was approached by the project team with a particular problem that was unforeseen at the design stage. The original design called for a rammed-earth wall for all the structural/architectural walls in this project.

One of the issues that surfaced with rammed earth in this application was the inability to provide enough strength for the structure's required bearing loads and seismic specifications. "The New Mexico building code defines qualified rammed earth as soil consolidated to full compaction that attains 300 psi (2 MPa) compressive strength and has a modulus of rupture equal to at least 50 psi (0.34 MPa).[1] This is a much lower strength than the 1450 to 5800 psi (10 to 40 MPa) compression strength range reachable by concrete."[2]

Another concern that arose was the thermal performance of a rammed-earth wall that is exposed both on the exterior of the building and the inside of the building. Frost-resistant walls made of steel studs with insulation were not part of the desired finished look. "The thermal resistance of rammed earth alone is not great enough to retain heat in a cold climate building. Obtaining a meager *R*-20 would require an 11.5 ft (3.5 m) wall thickness. Cold climate design dictates that rammed earth should be coupled with thermal insulation to attain higher thermal resistance."[2]

The solution to the thermal issue was to use an internal rigid insulation to increase the *R*-value. However, with the combination of these two key issues (structural and thermal resistance), it became apparent to the design team that alternates had to be explored.

Structural architecturally finished concrete was the only answer. However, due to the unique design of the building with varying geometry from the curved walls that oscillated up and down, and the free-formed configuration of the living roof, as well as new requirements to have sandblasted concrete walls, a conventional cast-in-place formed concrete wall would have been very difficult and costly. Even with exposed concrete walls, the thermal resistance issue required insulation to be sandwiched in the wall itself. This may have been easy for a flat, straight wall on a tilt-up building, but would have been extremely challenging in a cast-in-place wall with this unusual geometry.

The management team from Ledcor Construction, in conjunction with Whitewater Concrete, approached our management team for some alternative solutions using structural shotcrete

Fig. 1: VanDusen Botanical Gardens (Photo Credit: Nic Lehoux; Courtesy: Perkins+Will Canada)

methods. Through consultation with our operations and design team, a solution was born and the project proceeded.

Unusual Project Challenges

- An oscillating up-and-down structure with convex and concave curves throughout the project, similar to a roller coaster, made conventional forming of this project a very daunting task with time-related milestones difficult to overcome and to remain in budget.
- A uniform concrete finish on the exterior and interior of the wall. Both sides were to be sandblasted and remain with an exposed concrete finish.
- Internal insulation sandwiched in the wall itself.
- Designing the means, in collaboration with the engineer, by which to tie the two separate structural and architectural walls together with the integral insulation inside the wall, to support the intricate roof design that had additional loads from the green living roof on it.

To cast-in-place this structure with the integral insulation in the middle of the wall would have been difficult enough to achieve on straight walls, but to add in the extensive creative design of the oscillating curved structure and to achieve perfect elevations for the roof attachment made this project uniquely suited for the shotcrete process.

Solutions

Torrent created custom shoot panels made for the shotcrete industry. These panels were ideal for one-sided forming of the complex wall shapes on this project.

The ability to use our custom shoot panels and adjust them on the radius area was a huge time saver on this project. The one-sided forms worked well because only the exterior troweled face needed to be finished. Additionally, the ability to produce a perfectly curved radius, and a finished product with no need for any patching or repair work was unheard of on such a complex project. As the shoot panels were removed, spray-on insulation was applied to the exposed formed surface and became the inside (middle) of the wall. Once the insulation was applied and the steel reinforcing bars were installed, we then shot the inner wall. Thus, we created two superior exposed finish faces with multiple hand cut-in reveals and a smooth steel-troweled finish.

Once completed, the exposed wall surfaces were sandblasted and the resulting finish is amazing. Unlike cast-in-place concrete, with shotcrete, the higher density and compressive strength of the shot wall when sandblasted does not open up as much as normal cast-in-place concrete, leaving a much more uniform finish than possible with cast-in-place concrete.

Sustainability Benefits

- Reduction of lumber to build forms for walls. No one area of curved walls had the same radius, so every inch of the project required custom-built radius forms if cast-in-place concrete was to be used. With the use of shotcrete, standard shoot panels were able to be used—there were no radius panels whatsoever on this project.
- Reduction in trucking due to less need for lumber.
- Producing the structural walls for the project reduced time. Less carbon footprint realized on the site.
- Eliminating the need for patching and parging materials as per usual with cast-in-place concrete.

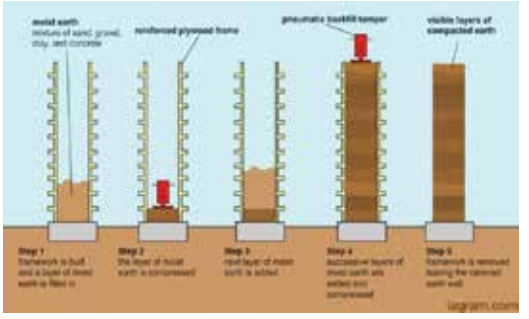

Fig. 2: Diagram of the construction process for a rammed-earth wall

Fig. 3: Completed feature wall prior to sandblasting. Exterior area view, post-shoot

Fig. 4: Torrent custom shotcrete panels

About the Gardens

VanDusen Botanical Gardens is self-sufficient, carbon-neutral, and has LEED Platinum certification. It has won numerous other awards for its design and implementation. Winning ASA's 2012 Outstanding Shotcrete Project of the Year Award for Architecture adds credibility to the shotcrete industry as an established and recognized process for building our cities and infrastructure. "Shotcrete is Concrete."

Fig. 5: Preparing one of the feature walls for shooting. Exterior area view prior to shoot

Fig. 6: Applying the steel trowel finish on the walls and detailing in the vertical architectural reveals

Fig. 7: Curved and oscillating up and down, structural and architectural sandblasted concrete structure for VanDusen Botanical Gardens

References

1. Government of New Mexico, 2006.*
2. Fix, S. and Richman, R., "Viability of Rammed Earth Building Construction in Cold Climates," Report, May 11, 2009.

**Contact the author at Torrent Shotcrete Structures Ltd. for more information.*

***Gary Hawkins**, Business Development Manager for Torrent Shotcrete Structures Ltd., has been in the construction formwork industry for over 25 years and takes care of the estimating and client management. Torrent's management team is comprised of individuals with extensive experience in the formwork industry who contribute to elevating the level of expertise in the structural shotcrete industry.*

Recognition for the success of this project particularly goes out to Torrent's Operations Manager, Carl King, whose attention to detail and understanding of building in general made this project successful, and T. Ross King, Founder of the company and pioneer of the shotcrete industry in Canada.

2012 Outstanding Architecture Project

Project Name
VanDusen Botanical Gardens

Project Location
Vancouver, BC, Canada

Shotcrete Contractor
Torrent Shotcrete Structures Ltd.*

General Contractor
Ledcor Construction Ltd.

Architect/Engineer
Perkins+Will Canada

Material Supplier/Manufacturer
Ocean Heidelberg Cement Group

Project Owner
Vancouver Board of Parks and Recreation

*Corporate Member of the American Shotcrete Association

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2012 Honorable Mention

Fort Mott State Park—Rehabilitation Phase I

By Warren Cruz

Fort Mott was part of a three-fort defense system designed for the Delaware River during the post-Civil War modernization period, situated on the Delaware River in Pennsville, NJ. Troops were regularly stationed there from 1897 to 1922. Construction started in 1872 and stopped in 1876 with only two gun emplacements and two magazines in the mortar battery completed. Plans were originally for 11 gun emplacements with 20 guns and a mortar battery with six emplacements, but construction never reached that point.

Shortly after World War I, Fort Mott and this three-fort system became obsolete as newly constructed Fort Saulsbury in Delaware became the principal defense on the Delaware River.

The federal government maintained a caretaking detachment at the fort from 1922 through 1943. New Jersey acquired this reservation as a historic site and State Park in 1947. It was then opened to the public in June of 1951 and remains open today for guided tours and walking tours.

Fort Mott held massive cannons to protect the mouth of the Delaware River from invaders. It was no wonder that the fort was originally constructed of solid, 20 ft (6 m) thick concrete walls and buried on one side of a huge earth berm. The interior walls were severely spalled and with deteriorated concrete ranging from 4 to 20 in. (100 to 500 mm) deep (refer to Fig. 1 and 2). The repair specification called for all deteriorated concrete to be removed. No. 5 (No. 16M) epoxy-coated steel reinforcing bars 18 in. (450 mm) long were doweled 2 ft (0.6 m) on center to anchor the new No. 5 (No. 16M) reinforcing bar cage with bars 18 in. (450 mm) on center (refer to Fig. 3 and 4). The repair method originally called for a "form-and-pour" repair approach. Cruz Concrete and Guniting Repair, Inc., proposed a dry-mix shotcrete approach instead and was accepted by the New Jersey State Parks Department. Four to 18 in. (100 to 450 mm) of shotcrete was placed over everything and restored back to the original lines, while recreating the original finish. Cruz Concrete was contracted to place the dry-mix shotcrete on 3520 ft^2 (327 m^2) of vertical walls, sloped walls, and columns. The shotcrete portion of the project lasted 3 weeks (refer to Fig. 5 and 6).

As a historic site, a major challenge on this project was providing 3000 psi (21 MPa) concrete to match the existing concrete. With all the common concrete technology of today using admixtures and additives, it was an accomplishment to match this lower strength level of the past and match the existing walls. Many mockup test panels were made using different colors and textures. Finally, one was chosen and Cruz Concrete was able to proceed.

Fig 1: Cannon pit before

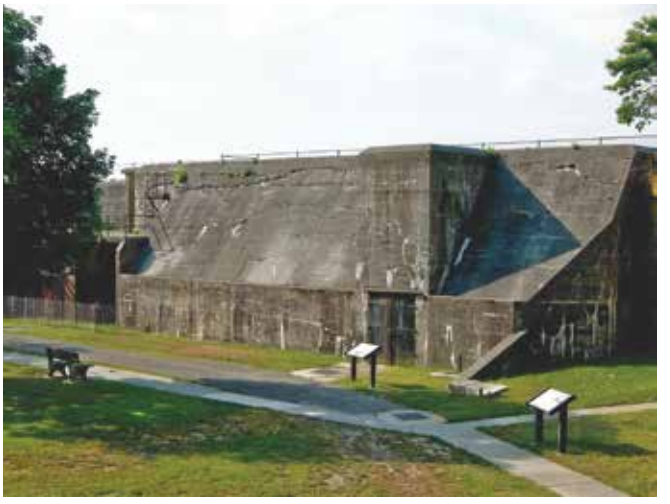

Fig. 2: Exterior Fort Mott before

The original construction also called for the use of natural cement, which the state wanted to match. Widespread in the past, natural cement is currently only manufactured in England. Cruz Concrete was able to offer a portland cement 4:1 grout mixture as an alternate to meet LEED sustainability requirements and match the requested finish.

At the completion of Phase I, the owner was so pleased with the results that the Phase II rehabilitation bid documents specified shotcrete as the concrete application method. This is another example where the flexibility and speed of shotcrete placement in the hands of a qualified contractor with experienced nozzlemen and crew produced a success story for the state of New Jersey and the industry.

Fig. 3: Fort Mott top wall templates

Fig. 4: Fort Mott water cistern

Fig. 5: Nozzleman placing shotcrete in the cannon pit

Fig. 6: Preparing the Fort Mott ground floor gutter

2012 Honorable Mention

Project Name
Fort Mott State Park—Rehabilitation Phase I

Project Location
Pennsville, NJ

Shotcrete Contractor
Cruz Concrete & Guniting Repair, Inc.*

General Contractor
Paragon Restoration Corporation

Architect/Engineer
Lammey & Giorgio Architects

Material Supplier/Manufacturer
Penn Jersey Concrete Ready Mix

Project Owner
State of New Jersey

*Corporate Member of the American Shotcrete Association

2012 Honorable Mention

Structural Repair of Galveston Island Historic Pleasure Pier Cycle of Life

By Hank Taylor

During the late 1950s to the mid-1950s, Galveston Island was a destination for those who came to Texas to have fun and conduct a little business. The Pleasure Pier, constructed in the early 1940s as a multi-purpose convention and entertainment venue, measures 1200 ft (370 m) long by 120 ft (37 m) wide and uniquely juts out over the Gulf of Mexico. A convention and exhibition hall was located on the main part of the pier. The middle section of the pier had an amphitheater for concerts and a large screen for movie projection. The end of the pier farthest from the beach was locally known as the "T" Head, the best fishing spot on the Gulf Coast.

Island locations along the Gulf Coast seem to attract hurricanes. Hurricane Carla in 1961 damaged many structures on the pier beyond repair; the pier eventually had to be scrapped completely clean. Local investors with the "build it and they will come" mentality designed and built a 10-story hotel on the pier known as The Flagship Hotel. It was built in 1965 with much fanfare and excitement as the first and only luxury hotel extending over a continental body of water. Unfortunately, the marine environment, including sea salt, winds, and high humidity, has led to a slow deterioration of all exposed materials (refer to Fig. 1). As a result, hotel occupancy gradually declined, funds for regular maintenance were reduced, and hotel guests on a tourist-dependent island were attracted to other venues. The hotel, under the ownership of the city of Galveston, was abandoned in 2005. Landry's Inc., a nationally recognized developer of entertainment, hospitality, and restaurant businesses, bought the pier from the city with expectations to redevelop the hotel and bring it into its holdings.

Fig. 1: Deteriorated columns between water line and deck

In 2008, Hurricane Ike, a Category 2 storm, caused serious damage to 17,500 island homes and businesses and severely ravaged the 10-story hotel, leaving it unsalvageable. The new owners envisioned the Galveston pier as an entertainment forerunner to existing piers in Santa Monica, CA, and Chicago, IL. Hurricane Ike changed their short-term needs but not their goal to restore the Galveston pier to the 1940 era when it was originally known as The Pleasure Pier. The new redesign was very ambitious and included a plan for 16 action-packed rides, a midway, and two restaurants on a deck pier now littered with storm damage, an abandoned hotel, and a concrete pier with added structural decay. The owner decided to demolish the hotel and structurally restore the concrete pier before installing any amusement rides, the entertainment midway, or restaurants. They hired the engineering firm of Stanley, Spurling & Hamilton from Houston, TX, to assess the pier and begin a preliminary design to structurally restore it. Considering the semi-tropical marine environment that included constant wave action, harsh UV exposure, airborne chlorides, and potential hurricanes, the accelerated deterioration and harsh conditions needed to be addressed with every engineering design and construction step.

Little or no maintenance over the 70-year life of the pier has resulted in exposed reinforcing steel with accelerated corrosion and concrete spalling at piles, beams, joists, and reflective overhead flat plates. The new design plan increased live- and dead-load factors on the pier, harmonic motion of ride equipment, anticipated high lateral wind load

Fig. 2: Surface preparation of deck support beams

Fig. 3: Surface preparation of pier columns

on buildings, and structural longevity that had to be assessed and designed into the restoration. During the design phase, Epoxy Design Systems, Inc. (EDS) worked closely with Stanley, Spurling & Hamilton Engineering to provide conceptual ideas for materials, as well as restoration means and methods to incorporate into the overall project. EDS provided expertise based on 35 years of structural concrete restoration and repair experience. Using experience from several successful past projects that used the shotcrete process and techniques to repair concrete structures, different repair methods and shotcrete materials were incorporated to meet design criteria, including technical test data for material choice, constructibility for different repair types and conditions, and coordination of materials with Quikrete. Specifications were developed for specific pier areas requiring different repair solutions (refer to Fig. 2 and 3). All corroded reinforcement with cross-sectional loss greater than 25% were replaced, anchored, and coated with anti-

Fig. 4: Scaffolding setup for open access to underside of deck

corrosion material in advance of any shotcrete material. Access to the pier underside and safe support of all workers was a major problem for the duration of the project over salt water with wave action around pilings, tidal fluctuation, afternoon storms, and constant prevailing winds. Once the 10-story hotel was demolished one floor at a time by a specialty demolition contractor, working platforms 120 x 200 ft (37 x 61 m) were suspended and anchored 7 ft (2.1 m) below the pier deck and at existing concrete columns. Betco Scaffold of Houston designed, engineered, erected, and sequentially moved multiple sections to designated work zones, beginning at the farthest point over water allowing safe access for EDS to structurally restore each pier element (refer to Fig. 4). Environmental restrictions were in place throughout the project by the city of Galveston, the U.S. Coast Guard, and the Environmental Protection Agency (EPA) for concrete demolition dust control, debris removal, and cementitious overspray during shotcrete placement. Large tarps, screens, netting, tethers, and tie-offs were present each day as workers restored each platform section in a predetermined repair sequence to completion (refer to Fig 5).

The on-site engineer inspected for sufficient removal of deteriorated/micro-fractured concrete; surface profile of mechanically prepared sound concrete; minimum 1 in. (25 mm) concrete removal behind existing in-place reinforcing; complete corrosion removal at reinforcing; new steel placement; anchoring and lap spicing; anti-corrosion coating; and constant measuring of shotcrete thickness, cover at reinforcement, density, compression, and consolidation. Presoaking the properly prepared concrete substrate to surface saturated dry (SSD) ensured a monolithic integrated bond line between enhanced micro-silica shotcrete pneumatically applied freeform using three C-10 dry-mix shotcrete machines purchased from Gunite Supply and Equipment in Houston, TX. Once each underside structural member received the required shotcrete thickness of material, the surface was struck and finished to match dimensions of the existing pier concrete. The on-site inspector monitored the shooting of test panels on a daily basis in accordance with material specifications accepted by the engineer and owner.

So life moves in a circular pattern, from Pleasure Pier to hotel to Pleasure Pier…truly historic.

About Epoxy Design Systems, Inc.

The company, established in 1977, is a specialty trade contractor that repairs, protects, and strengthens existing concrete structures in domes-

Fig. 5: Shotcreting deck beam overhead with very limited access height

tic and international commercial, industrial, and marine environments. EDS is a charter member of ASA. While most projects are within 500 miles (225 km) of Houston, TX, domestic projects have ranged from the Brooklyn Battery Tunnel, New York City, NY; the Southeast Financial Tower, Miami, FL; Arizona Power, Page, AZ, and a private owner in the remote high desert of Nevada, AZ. The locations of international projects include Aruba, St. Croix, Panama, Honduras, Chile, Thailand, and the U.S. Naval Facility on the island of Diego Garcia in the Indian Ocean.

***Hank Taylor**, Founder of Epoxy Design Systems, has been involved with infrastructure concrete repair since 1974. He is past ICRI Board member, has attended all but three World of Concrete conventions and several manufacturers training seminars, and was one of six people in the inaugural Sika Applicator Program. He is an ASA Founding Charter Member. Based in Houston, TX, he is President of the firm and joins 20 other fellow employees whose mission is to repair and restore America's infrastructure back to its original glorious state.*

By the Numbers

- 4,700,000 lb (2,100,00 kg) of Quikrete Shotcrete MS placed
- 17,000 lb (7700 kg) of supplemental steel reinforcement
- 70 employees
- 14 months

2012 Honorable Mention

Project Name
Galveston Island Historic Pleasure Pier—Structural Concrete Repair

Project Location
Galveston, TX

Shotcrete Contractor
Epoxy Design Systems*

General Contractor
Ardent Construction

Architect/Engineer
Stanley Spurling & Hamilton Inc.

Material Supplier/Manufacturer
The Quikrete Companies*/
Gunite Supply & Equipment*

Project Owner
Landry's Inc.

*Corporate Member of the American Shotcrete Association

2012 Honorable Mention

The North Burlington Skatepark Project

By David Youkhana

Fig. 1: Phase I preparations

Fig. 2: Construction

The North Burlington Skatepark construction project was part of a larger development, the Alton Campus, which includes Norton Community Park (a large urban sports park), High School, Library and Community Centre. The skatepark was built right in the middle of this $50,000,000 (CAD) development.

The skatepark is 14,000 ft^2 (1300 m^2) in area and has proven to be a destination not just for the citizens of Burlington but also for people from surrounding municipalities in southern Ontario.

The Norton Community Park Project was lead by John George Associates. Part of the professional design team included van der Zalm + associates inc. and New Line Skateparks, which were responsible for the integration, concept development, and detailed design of the skatepark.

Gateman Milloy was the General Contractor for the construction of Norton Community Park and subcontracted NewLine Skateparks to construct the skatepark. The construction value for the skatepark is $500,000 (CAD).

The first part of the construction included rough grading, excavating, and building the footings. The next phase included forming all the banks and transition areas (refer to Fig. 1). Welded wire mesh reinforcement was installed and wet-mix shotcrete was placed and cut to meet the demanding tolerances that were listed in the specification. Finishers provided a smooth (but not slippery) surface to maximize the performance and minimize the potential hazards to the skaters.

The transition and banks were shaped with a 7.5 ft (2.3 m) radius and ranged in vertical height between 4 and 5.25 ft (1.2 and 1.6 m). Wet-mix shotcrete material was pigmented to differentiate the transition between vertical and horizontal surfaces and allow skaters to better orient their position while jumping and completing tricks. Over 400 yd^3 (300 m^3) of concrete were used to complete the project (refer to Fig. 2 and 3).

Shotcrete played a key role in the completion of this project. The extremely tight tolerances would have been difficult to meet using any other

placement method. The use of two-sided forms would have lead to dramatically increased labor costs. Shotcrete also allowed the contractor to place concrete and build features on slopes as steep as 9 degrees. Access to the on-site work was also facilitated because the contractor was able to run hoses from the edge of the site to the shooting surfaces within the skatepark. Other placement methods would have required the use of expensive cranes or pumping equipment (refer to Fig. 4).

The flexibility and ease of placement in the shotcrete process allowed North Burlington to enjoy a beautiful, affordable community gathering place for fun and recreation (refer to Fig. 5).

David Youkhana *is the Quality Control Coordinator for the City of Burlington's Engineering Department with more than 43 years of experience in municipal roads, bridges, and construction materials (including specialized asphalt, concrete, and pipes). Youkhana has a diploma in Civil Technology and is a member of the Ontario Association of Certified Engineering Technicians and Technologists. For the past 16 years, he has been a volunteer coordinator, instructor, and trainer in the Bituminous Technology course with the Ontario Good Roads organization.*

2012 Honorable Mention

Project Name
City of Burlington—
North Burlington Skatepark

Project Location
Burlington, ON, Canada

Shotcrete Contractor
NewLine Skateparks Inc.*

General Contractor
Gateman Malloy GC

Architect/Engineer
NewLine Skateparks Inc.*

Material Supplier/Manufacturer
Dufferin Concrete/Putzmeister
Concrete Pumps*

Project Owner
City of Burlington

*Corporate Member of the
American Shotcrete Association

Fig. 3: View of skatepark on opening day (note pigment variations)

Fig. 4: Ease of equipment access

Fig. 5: North Burlington Skatepark completed

2012 Honorable Mention

Hydrodemolition and Shotcrete for Rehabilitating a Reservoir Spillway

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

The rehabilitation of a multi-curved reservoir spillway in Korea was successfully accomplished by hydrodemolition and shotcrete with careful consideration of the construction material specifications, the importance of curing, and careful sequencing of the field work. Hydrodemolition was adopted to selectively remove damaged concrete and the prepared surfaces were cleaned by compressed air jets and vacuum cleaners. Then, a high-performance wet-mix shotcrete offered the advantages of lower rebound, higher strength, better bonding, and improved durability.

The Scope of Work

The scope of work included a curved spillway and a vertical wall. The multi-curved spillway was 148 ft (45 m) long and 25.6 ft (7.8 m) high and the repaired vertical wall was 32.8 ft (10 m) long and 9.8 ft (3 m) high. Figure 1 shows the deteriorated spillway and vertical wall. The project started on May 29, 2010, and was completed on June 18, 2010.

The project owner was Korea Rural Community Corporation, which is a part of the Korean government. The high-performance wet-mix shotcrete was developed by Professor Yun, working at Kangwon National University and according to the requirements of the project owner. The shotcrete contractor was Daesang E&C, who also operated the hydrodemolition works.

Hydrodemolition Challenges

Hydrodemolition uses high-pressure water jets to break up concrete and is a popular alternative to jackhammering. Water is supplied to the robotic machine from a 20,000 psi (137.9 MPa) high-pressure pump with flows of 40 gpm (150 L/m). A hydrodemolition system consists of a high-pressure water pump(s), a robotic cutting head, and a support vehicle or trailer. The trailer carries the: 1) pump; 2) cutting equipment and vehicle; 3) spare parts and tools; and 4) fuel and water tanks. The hydrodemolition cutting depth is dependent on the length of time that the water jet is directed at the concrete surface. The contact exposure time is controlled at the robotic cutter. There are five parameters that determine the quality and depth of removal:

- Rotation speed of the nozzle;
- Angle of the nozzle to the surface;
- Height of the nozzle above the surface;
- Traverse speed; and
- Advance distance.

Hydrodemolition was required by project planners who had experienced its significant advantages over traditional impact methods—that is, jackhammers and roto-millers—in past work. There are many advantages of using hydrodemolition over traditional removal methods, including:

Fig. 1: Deterioration before rehabilitation: (a) spillway; and (b) wall

- The rough, irregular surface profile provides an excellent mechanical bond for all types of repair materials;
- Surface microfracturing caused by mechanical removal methods is eliminated;
- Exposed aggregates are not fractured, split, or damaged;
- Lower strength and deteriorated concrete (delamination) is selectively removed;
- Vibration to the surrounding structure is eliminated;
- Reinforcing bar is cleaned, eliminating the need for sandblasting;
- Reinforcing and other embedded metal elements are undamaged; and
- There is increased speed of concrete removal, which can reduce construction time.

The hydrodemolition work was very challenging because the spillway had multi-curved surfaces that were 25.6 ft (7.8 m) high. The robotic cutting head was guided by steel pipe rails, which were curved and installed over the curved spillway surface; then, the head was pulled along the rails by a winch system, as shown in Fig. 2(a). The spillway surface prepared by the hydrodemolition was perfect for bonding of shotcrete, as shown in Fig. 2(b).

The First Rehabilitation Project with Shotcrete in Korea

Wet-mix shotcrete has become a common process in tunneling in Korea since 1997; however, it is very rare to use it outside of tunnel work. This rehabilitation work was the first shotcrete project to take place in Korea using high-performance shotcrete outside a tunnel environment.

The coarse aggregate was a crushed limestone with a maximum size of 0.4 in. (10 mm) and the fine aggregate was a natural sand having a specific gravity of 2.60. The fine aggregate to the total weight of aggregates ratio was 65%. Shotcrete mixture designs generally require the use of a well-graded aggregate size distribution. The proposed shotcrete mixture also contained silica fume to reduce rebound, increase resistance to water washout, and decrease the permeability of the mixture. The use of silica fume also allowed the nozzleman to shoot the mixture at its wettest stable consistency, which contributes to proper reinforcing bar encapsulation in addition to facilitating surface finishing.

The shotcrete mixture was made with a mobile concrete mixer (refer to Fig. 3). One major advantage a mobile mixer has is that it can decrease or increase the slump of the mixture on demand, according to the dry/wet conditions of aggregates. Another advantage is that many shotcrete jobs are performed far away from a ready mix concrete batch plant. It can be extremely difficult to reach these remote sites with workable concrete using conventional means of producing concrete.

Fig. 2: Challenge of hydrodemolition at a multi-curved spillway: (a) robotic head at a curved surface; and (b) after hydrodemolition

Fig. 3: A mobile mixer supplying concrete to the shotcrete pump

The Overall Application Procedures

Daesang E&C Company undertook the planning, project management, and design of the project. Careful consideration was given to the construction material specifications and the importance of proper curing. These were both extremely important factors considering the hot temperatures expected during the project.

The field procedures for the project were as follows: 1) remove the damaged curved-concrete surface of the spillway by hydrodemolition; 2) set wire guide lines for controlling the overlay thickness and maintain the surface with a saturated surface-dry condition; 3) mock up panel test; 4) analyze test results; 5) mix with a mobile mixer; 6) shoot shotcrete; 7) finish the surface; 8) spray curing compound for immediate and temporal cure to resist early-age plastic shrinkage cracking; 9) cover exposed surfaces with wet burlap and sprinkle water for long-term curing; and 10) perform the final inspection and acceptance of the structure. Figure 4 illustrates the detail of field application procedures.

Mockup Test and Test Results

The mockup was constructed to demonstrate that the contractor, equipment, nozzleman, and finishing crew were capable of constructing the work with the desired quality. Cores of the test panel showed that all the reinforcing steel was thoroughly encapsulated in dense shotcrete without excessive voids, shadows, or entrapped rebound or overspray, as shown in Fig. 5. Grading of the cores was based on visual examination and measurements of defects, resulting in " Core grade 1" according to ACI CP-60. The mockup was kept on site and formed the standard for acceptance/rejection of future shotcrete work on site. Cores with a diameter of 4 in. (100 mm) were extracted for a series of test programs.

The tests for hardened concrete included compressive strength using a core cylinder of 4 x 8 in. (100 x 200 mm) and a beam of 4 x 4 x 18 in. (100 x 100 x 450 mm) according to ASTM C42 to monitor strength development at 1 day, 7 days, and 28 days. The compressive strengths were measured to be 3100 psi (21.4 MPa), 3480 psi (24.0 MPa), and 5800 psi (40.0 MPa) at 1 day, 7 days, and 28 days, respectively. It satisfied the specified requirements and achieved the EFNARC C55 Grade. The flexural strengths were 780 psi (5.1 MPa) and 885 psi (6.1 MPa) at 7 days and 28 days, respectively. The result of pulloff bond strength showed 290 psi (2.0 MPa), which was above the criteria of 200 psi (1.4 MPa).

Durability of the reservoir spillway is very important because it is naturally subjected to continuous cycles of freezing and thawing, as well as wetting and drying. The results of the ASTM C1202 rapid chloride permeability test,

Fig. 4: Field procedures

the ASTM C662 freeze-thaw resistance test, and ASTM C672 surface scaling test were important indicators for success.

Two cores were cut into 2 in. (50 mm) thick specimens and tested for rapid chloride permeability at 28 days after shotcrete placement. The results showed 934 and 906 coulombs, which rate as a "very low" permeability according to the ASTM C1202 guide.

The freeze-thaw resistance test of Type A was performed up to 300 cycles. The relative dynamic moduli were measured every 30 cycles. The final durability index after 300 cycles was 91, indicating very good freeze-thaw resistance.

The repetitive cycles of freezing and thawing will cause the concrete surface to scale if it does not possess adequate strength or the required volume of entrained air. Deicing chemicals used for snow and ice removal exacerbate the buildup of internal stresses in concrete and thereby contribute to the tendency to scale. The scaling resistance qualitatively determined by a visual arbitrary rating resulted in "0," which indicates no scaling. Figure 6 compares the specimen surface before and after 50 cycles of the surface scaling test.

Concluding Remarks

The rehabilitation project of the reservoir spillway was successfully done with surface preparation using hydrodemolition and then application of high-performance shotcrete with careful consideration of the material specifications, the importance of curing, and efficient

Fig. 5: Mockup panel test

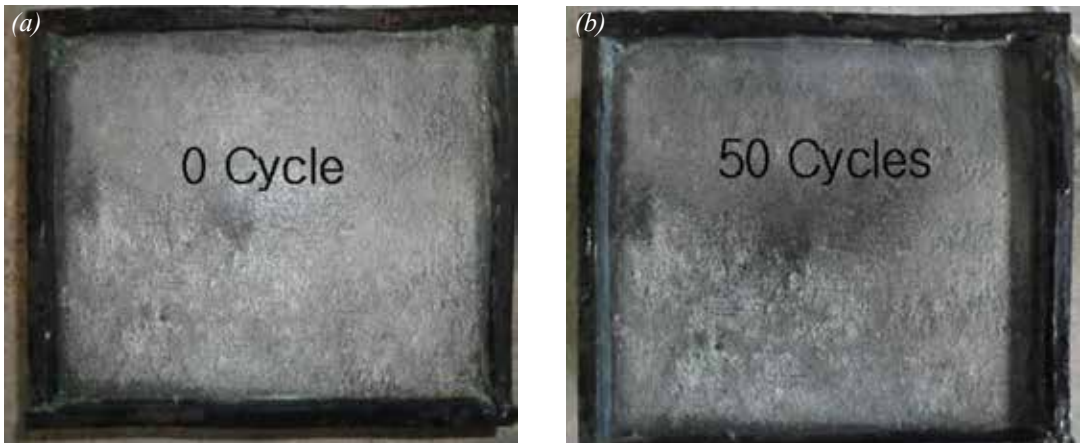

Fig. 6: Comparison of surface from surface scaling test: (a) before test; and (b) after 50 cycles

sequencing of the field work. A mobile mixer was used for easy supply and better quality control of the shotcrete mixture. Mockup test panels were shot to qualify the shotcrete crew and to further assess in-place material characteristics of the shotcrete, just as is done in the ACI Shotcrete Nozzleman certification program.

Overall, the rehabilitation work is the first shotcrete project outside of a tunnel to take place in Korea using high-performance shotcrete. This project could not be done without using shotcrete because the spillway had multi-curved surfaces and stiff slopes. The rehabilitated spillway will have excellent durability because it was built with high-performance shotcrete. The project was delivered to the client on time and met all the technical, architectural, and environmental requirements. Through the project, high-performance shotcrete provided its versatility and flexibility as a method of placing concrete over the multi-curved surface of the spillway.

2012 Honorable Mention

Project Name
Hydrodemolition and Shotcrete for Rehabilitating a Reservoir Spillway

Project Location
Chuncheon, Republic of Korea

Shotcrete Contractor
Daesang E&C

General Contractor
Daesang E&C

Architect/Engineer
Daesang Engineering Co.

Material Supplier/Manufacturer
Daesang E&C

Project Owner
Korea Rural Community Corporation

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 rehabilitation project.*

Sung-Yong Choi *is a Shotcrete Manager for Daesang E&C, a leading Korean company for shotcrete research and application. He received his PhD from Kangwon National University in 2009, with an emphasis on rheology and the air-void system of wet-mix shotcrete. He was a General Manager for this rehabilitation project in the field of shotcrete mixtures, equipment, application, and quality control.*

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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AMERICAN SHOTCRETE ASSOCIATION

2012 Carl E. Akeley Award

The seventh annual Carl E. Akeley Award was presented to R. Curtis White Jr. of Coastal Gunite Construction Co. for his paper, "Pineda Causeway Bridge Rehabilitation." This paper, published in the Winter 2012 issue of *Shotcrete* magazine, provided an informative review of how performance aspects of the specifications allowed shotcrete to replace the originally specified form-and-pump repair of this challenging infrastructure rehabilitation. The award was presented by Mark A. Campo, ASA Executive Director.

ASA established the Carl E. Akeley Award to honor his founding of what today is 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.

Past Akeley Award Recipients

- 2006 – Jean François Dufour, "State-of-the-Art Specification for Shotcrete Rehabilitation Projects"
- 2007 – Knut F. Garshol, "Watertight Permanent Shotcrete Linings in Tunneling and Underground Construction"
- 2008 – E. Stefan 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 – Lihe (John) Zhang, "Is Shotcrete Sustainable?"
- 2011 – Charles S. Hanskat, "Shotcrete Testing—Who, Why, When, and How"

Carl E. Akeley

R. Curtis White Jr.

2012 ASA President's Award

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 2006, six well-deserving individuals were awarded the President's Award, all of whom dedicated their time and energy to advance the shotcrete industry. While there are many other individuals who warrant consideration as this year's recipient, ASA President Joe Hutter elected, for the first time, to recognize an organization as the winner of the 2012 President's Award.

This year, the ASA President's Award was presented to Quebec City's Université Laval in recognition of the many years of research and development that this institution has dedicated to shotcrete materials and processes. In 1992, Université Laval became a founding member of The Inter-University Research Center on Concrete (an industrial Chair funded by several concrete industry partners and the Canadian government) and helped lead much of the shotcrete research undertaken by the Chair.

Today, Université Laval is one of North America's only universities with a fully operational shotcrete research lab set up with real-scale shotcrete equipment for both dry and wet processes. This investment has allowed Laval to become a sponsoring group for the American Concrete Institute (ACI) Nozzleman Certification Program and conduct certification sessions in both French and English for contractors in Quebec.

The results of their research efforts extend beyond the borders of North America. Internationally recognized research projects have resulted in over 15 graduate students completing a master's program on shotcrete-related studies and two who have completed a PhD while conducting shotcrete research. In many cases, the results of this research have improved the plastic and hardened properties of shotcrete and have been adopted in the specifications of many of North America's best-known specifying authorities.

Université Laval's contribution to the shotcrete industry can be measured not only by their research but also by the quality of graduates they continually provide our members. Many Laval graduates continue to work in the shotcrete industry today—some participating on ASA committees and others who have participated on and Chaired ACI (shotcrete) committees. Congratulations to Université Laval on their contribution to our industry and continued success!

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- **INFLUENCE** ASA's direction in serving members and growing the industry
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- **EDUCATE** the construction world on the advantages of the shotcrete process through in-house presentations to engineers and specifiers
- **PROMOTE** the benefits of shotcrete at national trade shows
- **COORDINATE** proper specification of shotcrete in private and public specifications and national codes and standards
- **ENGAGE** DOT and other Public Authority officials with a variety of ASA resources and outreach efforts
- Take advantage of **TARGETED MARKETING** in national and regional organizations and publications
- **ENABLE** owners and specifiers to embrace shotcrete with a portfolio of tools designed to give them an understanding of and confidence in the shotcrete process

At a time when more and more companies are demanding effective use of their dollars, more and more companies in the shotcrete industry are realizing the benefits of becoming an ASA Corporate Member (***25% increase in the number of ASA Corporate Members over the last 2 years***).

Take the step that will help grow your organization and industry—become an ASA Corporate Member today

For more information on ASA membership, visit www.Shotcrete.org.

Top Ten Sustainability Benefits of Shotcrete

The United States Green Concrete Council's (USGCC) book, *The Sustainable Concrete Guide—Applications*, includes a list of the top 10 sustainability benefits of shotcrete in its chapter on shotcrete. Over the next 10 issues of *Shotcrete* magazine, this Sustainability column will elaborate on each one of the listed advantages. Previous discussion of advantages from past issues can be viewed on the ASA website at **www.shotcrete.org.** Look in the "Why Shotcrete?" section for "Sustainability."

U.S. GREEN CONCRETE COUNCIL

1. Formwork savings of 50 to 100% over conventional cast-in-place construction.
2. Formwork does not have to be designed for internal pressures.
3. Complex shapes require very little—if any—formwork.
4. Crane and other equipment savings or elimination.
5. Labor savings of at least 50% in repair applications.
6. New construction speed savings of 33 to 50%.
7. Speed of repair reduces or eliminates downtime.
8. **Better bonding to the substrate enhances durability** (see below).
9. Adaptability to repair surfaces that are not cost-effective with other processes.
10. Ability to access restricted space and difficult-to-reach areas, including overhead and underground.

Better Bonding to the Substrate Enhances Durability

Concrete is, by the definition of sustainability, the perfect construction material. It is the most common construction material on the planet. Concrete can be easily produced from widely available, plentiful natural resources, and it is completely recyclable. History has proven that structural elements made from concrete tend to last longer and require less ongoing maintenance than any other common construction material. History has also proven that all concrete elements eventually deteriorate or need to be reconfigured over time.

New concrete construction currently benefits from an array of material advancements and innovative construction techniques that have substantially improved the sustainability of modern elements constructed from concrete. The use of supplementary cementitious materials such as slag, fly ash, and microsilica and the more recent use of other recycled materials in the production of greener concrete reduce the environmental impact of new concrete construction.

But what about the immense inventory of existing concrete structures? Wear, exposure, deterioration, or obsolescence ultimately mandates the life span of all concrete elements. The ability to repair or reconfigure, rather than replace, existing concrete elements enhances sustainability, as repair methods can significantly extend the structures' useful service life (refer to Fig. 1).

Bonding Becomes the Critical Element

The ability to form a durable bond interface between the existing substrate and the new concrete is critical to nearly every concrete reconstruction or repair. Typical structural designs require both the existing and replacement material to perform as a single cohesive element. Research has proven that durable, permanent bonds can be attained by using properly prepared substrate conditions in conjunction with shotcrete placement methods. Studies focusing on the bond qualities of shotcrete have proven that a sound substrate surface with an adequate roughness profile provides a suitable surface to form a durable bond. Shotcrete applied to a properly prepared substrate offers a significantly stronger and more durable bond than traditional casting placement methods. Other factors, such as surface moisture conditions, impact energy, shrinkage, and the mixture properties of the repair materials, can also affect the long-term bond quality. For many projects, bond quality will have the strongest influence on repair durability (refer to Fig. 2).

Why Shotcrete Placement Methods Increase Bond Quality

Pneumatically applied shotcrete is capable of producing a stronger, more durable bond to cementitious, masonry, or stone substrates than any other common application method. Understanding the reason behind this requires insight into the principles of the shotcrete process. Both wet- and dry-mix shotcrete's superior bond properties are not due to mixture proportion differences between shotcrete and traditional

concrete. Bond quality with shotcrete is derived from the very high energy imparted to the surface during shotcrete placement. Traditional casting placement methods rely on new material bonding to an existing substrate, essentially by contact. Conversely, shotcrete placement methods propel material to the substrate at a high velocity. This process significantly modifies the mixture's proportions at the bond plane. As shotcrete material is initially placed, impact energy causes most of the mixture's coarser components to bounce, rather than stick, to the substrate surface. Only the mixture's smallest particles—the fine paste—can accumulate. As the paste layer builds, larger particles become embedded and rebound subsides.

It is shotcrete's high-velocity nozzle stream, through the tendency of fast-moving larger particles to ricochet off a hard surface, which produces a tight, well-compacted paste layer, driven into the surface irregularities at the bond plane. This perfect material arrangement at the substrate surface facilitates an exceptionally strong crystalline connection—the primary element of a durable bond (refer to Fig. 3).

Defining a Durable Bond

Concrete can be designed to possess a very high compressive strength of 4500 to 7500 psi (30 to 50 MPa) or more. Its pull-apart resistance is comparably quite low at 145 psi (1 MPa). Bond strength values between new and existing concrete should be similar to the strength of the existing concrete. Therefore, for a bond to be considered durable, its bond strength should meet or exceed the pull-apart resistance of the underlying material. Typically, pneumatically applied shotcrete, when exposed to pull-apart or tensile loading, does not fail at the bond plane but, rather, within the substrate layer. This proves that the best possible bond has been attained.

Structural designs requiring durable bonding typically specify routine bond pulloff testing. Bond strength is commonly measured by coring through the shotcrete layer and into the substrate. A tensile load is applied to the surface of the core and then increased to the point of failure. The measured load failure divided by the core surface area provides a numerical bond strength. Both wet- and dry-mix shotcrete applications produce very good bond strength, typically 145 psi (1 MPa) or higher.

Bond quality is a primary requirement for repair durability. Shotcrete's unique material arrangement at the substrate surface enhances durability through improved bond strength.

Note: Bonding agents are not recommended for shotcrete applications. Bonding agents interfere with shotcrete's natural bond qualities and can create unreliable bonding.

Resources

ACI CP 60(09), 2009, *Craftsman Workbook*, American Concrete Institute, 92 pp.

Beaupre, D., 1999, "Bond Strength of Shotcrete Repair," *Shotcrete*, V. 1, Spring, pp. 12-15.

Duckworth, O., 2011, "Can Nozzleman Skill Affect Bond Quality?" *Shotcrete*, V. 13, Winter, pp. 30-33.

Fig. 1: Exposed concrete ceiling element has deteriorated beyond its useful service life

Fig. 2: The bond characteristic of shotcrete is an important issue for the engineer because it strongly affects repair durability

Fig. 3: Note fine materials developing a paste layer at leading edge of the nozzle spray pattern. Although larger particles have impacted this area, they cannot embed until a sufficiently thick paste layer develops

AMERICAN SHOTCRETE ASSOCIATION

ASA Membership Benefits

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Company and specialty information listed in ASA's online Buyers Guide and in hard copy via *Shotcrete's* annual Buyers Guide	X					
Discount on ACI Nozzleman Certification and Education	X					
Opportunity to submit items for Industry News and New Products & Processes sections of *Shotcrete* magazine at no charge	X	X	X		X	
Discounted ASA Member prices on all ASA products	X	X	X	X	X	X
Networking and participation opportunities at Annual Membership Meeting and committee meetings	X	X	X	X	X	X
Opportunity to respond to bids from our Online Project Bid Submittal Tool	X	X				
Subscription to quarterly *Shotcrete* magazine (hard and electronic copy)	X	X	X	X	X	X*
Links to shotcrete related government projects open for bid (*sent twice a month in the member edition of the ASA e-newsletter*)	X	X	X	X	X	X
Permission to include ASA logo on corporate letterhead and business cards	X	X	X		X	
Permission to display ASA logo on company Web site	X					
Discounted pricing on advertising in *Shotcrete* magazine, including free linked logo advertising from the ASA homepage during your advertising quarter	X	X	X		X	
Voting privileges at meetings and director/officer elections	X	X	X			
Free advance general admittance registration to World of Concrete	X	X	X	X	X	X
Opportunity to submit entries for the annual Outstanding Shotcrete Project Awards Program	X					
Free Lunch & Learn Seminars upon request					X	
Complimentary copy of ASA's Shotcrete Specifiers Education Tool—a 4GB USB flashdrive					X	
Complimentary copy of "Sustainability of Shotcrete" each year	1				1	
Discounted Corporate Additional ASA Memberships are available for all company employees ($150 savings per employee)	X					
Discount on ASA Underground Shotcrete Education Program	X					
Complimentary copy of ASA's Annual Nozzlemen Compilation each year				1		
Complimentary ASA shotcrete brochure each year	25	1	1		1	
Complimentary ASA reflective hardhat sticker each year	10	1	1	1		
Education & promotion of your shotcrete industry to the overall concrete industry	**X**	**X**	**X**	**X**	**X**	**X**

* Student members outside North America will only receive electronic copies

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❑ Water Reducing-High Range
❑ Water Reducing-Mid Range
❑ Water Reducing-Normal
❑ Water Reducing-Retarding
❑ Water Repellent

Cement/Pozzolanic Materials
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❑ Cement-Portland
❑ Cement-White
❑ Fly Ash
❑ Ground/Granulated Slag
❑ Metakaolin
❑ Pozzolan
❑ Silica Fume-Dry
❑ Silica Fume-Slurry

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❑ Rock Carving
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❑ Structural
❑ Swimming Pools/Spas
❑ Tunnels
❑ Walls
❑ Water Features

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❑ Accessories
❑ Adaptors
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❑ Bowls
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❑ Wear Plates

Fibers
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❑ Glass
❑ Steel
❑ Synthetic

Shotcrete Materials/Mixtures
❑ Dry Mix
❑ Steel-Fiber Reinforced
❑ Synthetic-Fiber Reinforced
❑ Wet Mix

Propex Expands Fibermesh® Distribution with Masons Supply

Propex Operating Company, LLC, announced that Fibermesh®, a leading brand in concrete reinforcing fibers, will now be available in the Pacific Northwest through Masons Supply.

According to Ralph Bruno, Propex Executive Vice President, the selection of Masons Supply as a Distributor for Propex means Fibermesh will be easy to buy in the Pacific Northwest markets. "We are proud to partner with Masons Supply as we continue to expand our infrastructure solutions," said Bruno. "This is the latest in a series of growth initiatives to better service our ready mix and precast customers."

"Fibermesh, the leader in concrete fiber technology, is constantly researching to find new, innovative, and cost-efficient solutions for concrete," stated Pat Merriman, Masons Supply Sales Manager. "Masons' partnership with Propex will allow us to expand our product offering. Masons, for many years, has been involved with supplying concrete accessories and the formwork for containing concrete. Now, with the addition of Fibermesh, we are involved with the concrete itself. Masons can supply a complete package of concrete solutions for our customers."

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

Production Begins at King's New Boisbriand Facility

Twenty months after the purchase of a new production facility in the Montreal suburb of Boisbriand, QC, Canada, King Packaged Materials Company is pleased to announce that production from this facility is underway. Business growth in Quebec and the Northeastern United States stretched the production capacity of the old Blainville plant and led to the purchase of the new Boisbriand facility in 2010. A dramatic increase in production capacity and warehouse space makes the new facility 400% larger than that in Blainville. The new plant will also allow for further growth of King's consumer, construction, and masonry products divisions for many years to come.

The new production lines and computer-controlled batching system at the Boisbriand plant will allow for recycling of waste material and improved batch accuracy for better quality control. The Boisbriand plant is home to King's new quality control lab, which includes a 1288 ft^2 (120 m^2) product training facility. King's Boisbriand facility represents a significant commitment to the company's customers and employees. The new plant is truly a world-class facility that will serve the company well for decades to come. For more information, please contact Mark Lowry at mlowry@kpmindustries.com or visit **www.kingshotcrete.com**.

Genesis 3 Reaccredited as an Authorized Provider of IACET CEUs

The International Association for Continuing Education and Training (IACET) has awarded reaccreditation status to Genesis 3, Inc. IACET Authorized Providers are the only organizations approved to offer IACET Continuing Education Units (CEUs). The accreditation period extends for 5 years and includes all programs offered or created during that time.

"Genesis 3 is proud of our education programs, which train hundreds of builders, designers, and landscape professionals each year in important topics such as construction, design, engineering, and business skills so that our members stay on the cutting edge," stated David J. Peterson, PE, SWD, Platinum, Education Council Chairman. Peterson added, "Our renewed partnership with IACET is a demonstration of our commitment to lifelong learning and high standards for all of our programs, and we are very pleased to join such a prestigious organization as well as an elite group of organizations that offer excellent continuing education and training programs."

To achieve Authorized Provider accreditation, Genesis 3 completed a rigorous application process, including a review by an IACET site visitor, and successfully demonstrated adherence to the ANSI/IACET 1-2007 Standard addressing the design, development, administration, and evaluation of its programs. Genesis 3 has pledged its continued compliance with the Standard and is now authorized to use the IACET name and Authorized Provider logo on promotional course material. In addition, Genesis 3 is now linked to the IACET website and is recognized as offering the highest quality continuing education and training programs.

PCA Announces Management Changes

The Portland Cement Association (PCA) has announced management changes designed to shift leadership to Washington, DC, in support of a renewed emphasis on national advocacy efforts.

"Over the past 10 years, we have debated the merits of our national association becoming more DC-centric," said PCA Chairman of the Board Aris Papadopoulos in an announcement of the changes. "The time has come to adapt to this new reality of the cement industry."

Effective September 6, 2012, Greg Scott, PCA's Senior Vice President of Government Affairs, has been promoted to President. He reports to Brian McCarthy, PCA's current President/CEO based in Skokie, IL, who will remain with PCA until year-end as CEO.

On January 1, 2013, Scott will assume the position of President/CEO of PCA. Although PCA's President/CEO will be based in Washington, DC, the Skokie office will continue to operate as an important resource for North American and regional promotion and advocacy efforts.

ICRI Celebrates 25 Years Serving the Repair and Restoration Industry

In May of 1988, more than 70 people representing the varied aspects of the concrete repair industry gathered in Naperville, IL, to lay the groundwork for what is now known as the International Concrete Repair Institute (ICRI). Concerned about the quality of repairs being performed, the group's objective was to bring together those truly interested in improving the concrete repair industry and use their knowledge and efforts to bring about meaningful change. What began as the International Association of Concrete Repair Specialists (IACRS) has grown into the leading resource for education and information to improve the quality of repair, restoration, and protection of concrete and other structures.

During its first 25 years, the organization not only changed its name but has also grown to represent more than 2000 industry professionals in contracting, engineering, and manufacturing. ICRI members are directly responsible for 17 unique and essential technical guidelines that have defined quality concrete repair. ICRI has also extended its reach by chartering a total of 36 chapters across the United States and Canada, giving its membership local and national presence.

To honor these and the many other achievements of ICRI, the organization will be celebrating throughout 2013, starting with a special commemorative issue of the *Concrete Repair Bulletin* (*CRB*) (January/February 2013), highlighting the history of ICRI and celebrating 25 years of achievements.

No anniversary is complete without celebrations, so events are planned for all normal ICRI meetings and conventions; everything starts with an evening at Chateau Nightclub & Gardens in Las Vegas during World of Concrete. Then it's on to a fantastic party being planned for the Spring Convention, March 20-22, 2013, at the TradeWinds Island Resorts in St. Pete Beach, FL. The celebrating

winds down with a special event at the Fall Convention, November 12-15, 2013, at the Fairmont Hotel in Chicago, IL.

For more information on these and other ICRI events, visit **www.icri.org** or contact Dale Regnier, Manager, Marketing & Chapters, at 847-827-0830.

ASTM International and AASHTO Agreement Benefits Road Construction and Transportation

The signing of an Agreement on Standards between ASTM International and the American Association of State Highway and Transportation Officials (AASHTO) solidifies coordination between two organizations working in the common interest of highway construction, safety, maintenance, and sustainability. ASTM International President James A. Thomas and AASHTO Executive Director John Horsley entered into the agreement at AASHTO headquarters in Washington, DC. The document is an outgrowth of the ongoing relationship between the two groups and serves as a future basis for continued mutual cooperation on the development and publication of standards related to highway construction.

"ASTM International is pleased to enter into this agreement with AASHTO," says Thomas. "We hope that it will foster better coordination in mutual areas of interest, reduce unnecessary duplication of effort, and be responsive to industry needs in an efficient and collaborative manner."

By supporting the science and technology of highway construction, road safety maintenance, and sustainability, ASTM International standards help to ensure that roadways are reliable, safe, and built to last. In the transportation field, several ASTM technical committees develop the standards relied upon by the industry, such as ASTM Committees C01, Cement; C09, Concrete and Concrete Aggregates; D04, Road and Paving Materials; D18, Soil and Rock; D35, Geosynthetics; and others. For over 100 years, ASTM International has developed more than 1000 standards that address the needs of road construction and transportation.

Through AASHTO, the nation's preeminent transportation experts provide an unparalleled resource for the development of more than 125 volumes of standards and guidelines that are used worldwide in the design, construction, maintenance, operation, and administration of highways, bridges, and other transportation facilities.

"A top priority at AASHTO is to find faster and smarter ways to build the transportation systems that the economy and communities depend on," said Horsley. "This agreement will help our organizations to avoid duplication of effort and streamline the process—saving both time and precious resources."

Industry Personnel

Strata Hires Mark Sanders as President and CEO of Strata Proximity Systems

Mark Sanders

Strata Worldwide LLC has announced the hiring of Mark Sanders as President and Chief Executive Officer of Strata Proximity Systems LLC.

Mark Sanders, the former Joy Global Vice President of Corporate Marketing, will be focusing on customer needs to drive and improve product development. With over 25 years of experience in the mining industry, Sanders brings strong market understanding, manufacturing know-how, and international business development experience to Strata Worldwide and its proximity systems.

Prior to joining Strata, Sanders worked at Joy for more than 26 years. During that time, he held a succession of positions, including Manufacturing Manager, Vice President Supply Chain, and Managing Director of both the China and the Americas business units.

Sanders comes from a family with a rich heritage in the mining industry. He graduated from the University of Nottingham, Nottingham, UK, with a degree in mining engineering and later earned his MBA from the University of Pittsburgh, Pittsburgh, PA.

At Strata, Sanders will work directly with customers to understand their needs and help align and grow the Strata proximity business globally.

Strata Worldwide is a global leader in mine safety solutions. The company's product line includes wireless communications and tracking systems, emergency mine refuge chambers, secondary roof support products, proximity detection systems, and mining construction services. Strata is committed to the design and development of technologies that are beneficial for today and lay a foundation for improved solutions in the future. Headquartered in Atlanta, GA, the company has service and sales support offices in the mining regions of the United States, Europe, Australia, South Africa, China, and Mexico.

CCS Group Welcomes Lance Paulsen

CCS Group welcomes Lance Paulsen as the new Operations and Business Development Manager. He will be working closely with the production

crews and customers to ensure all project objectives are met in a safe, timely, and professional manner.

Paulsen joins CCS Group with 40 years of experience. While working for the family's construction company as a youth, he built "bunker" silos, tilt-up silos, and confinement structures. Eventually becoming involved in all facets of the construction industry, he started his own company performing underground sewer and water projects, commercial building, and real estate development. He has experience in all aspects of company management with an emphasis on business growth and personnel development.

Paulsen received his bachelor's degree in construction management from the University of Nebraska, Lincoln, NE. He is a Past President of the Associated General Contractors Heavy-Highway Chapter in Nebraska and a Past Chairman of the Nebraska State Chamber of Commerce. Paulsen holds a Well-Drillers License in Nebraska and Kansas; is a current Board member and Committee Chairman for the Society of Marketing Professional Services, and is also a member of The Grain Elevator and Processing Society (GEAPS).

BASF Appoints New Manager of Technology for Admixture Systems Business

BASF
The Chemical Company

Paul Seiler

The North American Admixture Systems business of BASF's Construction Chemicals division has announced that Paul Seiler has been named Manager of Technology, responsible for the development of admixture and concrete technologies and customer support. Seiler will be based in the Beachwood, OH, headquarters, effective immediately.

In his new role, Seiler will manage the Admixture Systems business's Technology Department, which formulates innovative products, develops new technologies, and serves as a testing and support resource for concrete producer customers. In addition, the department is involved in developing test methods, procedures, and models to assist customers in the implementation of new technologies.

"The Manager of Technology position is a key role in our business," said Gabriel Cottrell, BASF Admixture Systems business manager. "In just the past few years, we have introduced groundbreaking technologies such as the Green Sense® Concrete mixture proportioning optimization service, as well as a brand new class of workability-retaining admixtures. Paul Seiler has the technical proficiency, practical experience, and innovative spirit to help us continue to bring to market new technologies that will help our concrete producer customers differentiate themselves today and in the future."

Seiler comes to BASF from Votorantim in Brazil, where he served as Technology and Process Manager and directed the business's research and development efforts for mortars, tile adhesives, grouts, hydrated lime, gypsum, and white cement. Prior to that, Seiler was Technology and Product Manager for Viapol, now part of The Euclid Chemical Company, in its Construction Chemicals division. He also spent 10 years as Technology and Production Manager for BASF Construction Chemicals in South America.

Seiler received his chemical and industrial engineering degrees from Centro Universitário da FEI, São Bernardo, Brazil, and his Executive MBA in industrial management from Fundação Getúlio Vargas, São Paulo, Brazil.

Justin Leckie Joins R G Johnson Company

Justin Leckie

R G Johnson Company welcomed Justin Leckie as the newest member of their office family. Leckie joins the organization as an Assistant Project Manager. Leckie attended Dennison University, Granville, OH, and then attended Case Western Reserve University, Cleveland, OH, for post-graduate school, where he received his MBA. He and his wife, Gina, now live in Upper St. Clair, WA.

Leckie was previously with PNC, where he helped manage the development and launch of Administrative Advantage, an online payment solution, now included in the PNC Product Suite.

Leckie hopes to bring a new, fresh perspective to the Company, with which he can contribute innovative ideas to carry R G Johnson Company's success into the future.

2012-2013 ASA Graduate Scholarships Awarded

The 2012-2013 ASA Graduate Scholarships have been awarded to Natalie Boyer and Sebastien Girard. Each student received a stipend of $3000 (USD) for tuition, residence, books, and materials. These scholarships are awarded each year to students pursuing higher education in the field of concrete with an interest and potential for professional success in the shotcrete industry. Established in 2008, the ASA Graduate Scholarship Program seeks to identify, attract, and assist outstanding graduate students in their pursuit of careers in the field of concrete, particularly in the application of the shotcrete process. This program opens each year in late spring. Visit **www.shotcrete.org** and get details in "Grad Scholarships" in the "Education/Certification" section.

Natalie Boyer

Natalie Boyer graduated from the University of Illinois, Urbana-Champaign with a BS in architectural studies. She is currently pursuing her master's of architecture degree with an emphasis in structural systems from the same institution. Boyer sees the role shotcrete plays in structural systems and restorations—another area of interest—as significant and advantageous.

Sebastein Girard

Sebastien Girard received his BEng in civil engineering from the Université Laval. He is currently pursuing his master's degree in civil engineering from Laval as well. Concurrent to his studies, he works as a Forensics Engineer Assistant, evaluating defects in concrete structure. This work has spurred his graduate studies in material performance.

ASA Spring Committee Meetings

All eight of ASA's standing committees will meet on Saturday, April 13, 2013, at the Hilton & Minneapolis Convention Center in Minneapolis, MN. The following tentative schedule includes two networking breaks that will allow all attendees to connect with their fellow shotcrete professionals.

In addition to networking opportunities, ASA committee meetings offer participants the opportunity to provide input on ASA efforts and become an integral part of ASA's overall mission. These meetings do not require preregistration and are open and free to anyone who has an interest in the shotcrete process. If you are involved in the shotcrete industry, you should plan to attend.

8:00 AM-9:00 AM
ASA Education Committee

9:00 AM-9:50 AM
ASA Sustainability Committee

9:50 AM-10:10 AM
Morning Networking Break

10:10 AM-11:00 AM
ASA Pool & Recreational Shotcrete Committee

12:00 PM-12:30 PM
Lunch

12:30 PM-1:30 PM
ASA Safety Committee

1:30 PM-2:20 PM
ASA Publications Committee

2:20 PM-2:40 PM
Afternoon Networking Break

2:40 PM-4:00 PM
ASA Marketing/Membership Committee

4:00 PM-5:30 PM
ASA Board of Direction

FREE On-Site Shotcrete Informational Presentations

Learn more about the shotcrete process—for Architects, Engineers, and Specifiers

The shotcrete process offers numerous quality, efficiency, and sustainability advantages, but proper knowledge of the process is critical to the creation of a quality specification and for the success of any specifier/owner employing the process.

ASA Informational Presentations are **FREE** to the host organization for five or more architects, engineers, or specifiers. If you work with firms that specify or might potentially specify shotcrete and would like them to become better informed about its benefits and proper use, please let them know about this opportunity to learn!

- Introduction to the Shotcrete Process
- Shotcrete for Underground Construction
- Shotcrete for Repair and Rehabilitation of Concrete Structures

ASA is a registered AIA/CES provider.

Arrange for an ASA Informational Presentation today!
info@shotcrete.org or 248-848-3780

Shotcrete FAQs

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

Question: Which method of placing concrete provides a longer service life—traditional cast-in-place concrete with two-sided forms or shotcrete?

Answer: Shotcrete is a placing method for concrete. Wet-mix shotcrete will be very similar in density to fully consolidated concrete when the concrete mixture designs are similar. Properly mixed and shot, dry-mix shotcrete may have a slightly higher density. Properly designed, placed, and cured, both concrete and shotcrete will give an excellent service life.

Question: I have a swimming pool that appears to have shrinkage cracks in the floor. I have tried to inject an epoxy, but the cracks are too small. Do you have any suggestions?

Answer: There are a wide variety of epoxies and polyurethanes used for crack injection. Smaller crack widths would require a lower-viscosity material to penetrate the crack. You should contact an engineer or injection specialist experienced in shotcrete and cracking issues to evaluate the cracking and make a specific recommendation for repair. Proper concrete mixture design, placement techniques, and early water fogging and curing can help to reduce plastic shrinkage and drying shrinkage cracking in the future.

Question: To keep shrinkage cracking sufficiently tight so as not to cause reflective cracking in the plaster layer, what is the proper depth of reinforcing steel from the shotcrete surface in swimming pool applications?

Answer: This question should be addressed by a qualified engineer with experience in designing swimming pools and well-versed in shotcrete technology. Shotcrete is a method of placing concrete and the parameters that work for concrete cover work for shotcrete.

Good practices for placing shotcrete or concrete include:

1. Predampening the soil that the concrete/shotcrete is placed against;
2. Ensuring that the reinforcing bar temperature is not too high; and
3. Early curing of the shotcrete surface and maintenance of curing for the specified duration. If no duration is specified, a 7-day wet cure is recommended.

Using fibers in the shotcrete/concrete can also help control surface early-age plastic shrinkage cracking.

Question: Can shotcrete be effectively used to repair holes in an old 8 ft (2.4 m) diameter storm sewer tunnel constructed of stone/brick/mortar? One of the holes is completely worn through to the earthen backfill material. The other two holes are missing the innermost layer of stone masonry, but the outer layer of masonry is still in place.

Answer: The friction coefficient *n* of well-finished shotcrete for use in Kutter's equation (and, more streamlined, Manning's equation) is generally used as 0.012. Shotcrete is used not only to improve flow characteristics of brick, corrugated metal, or any other pipe construction but can also be conventionally reinforced as a structural liner to eliminate the need for liner plates or other pipe-lining alternatives.

Question: A circular concrete tank built in the 1980s is to be resurfaced due to cracks in the exterior shotcrete lining. It has been proposed that the existing surface will be hydroblasted. Is there a concern that the shotcrete may contain asbestos?

Answer: No, there is no reason to assume that the shotcrete would contain asbestos. Shotcrete linings typically contain sand and cement. Asbestos was commonly used for pipe insulation and high-temperature industrial uses and not for shotcrete.

Question: We are a shotcrete contractor in Gold Coast, Australia. We have noticed that in the United States, you use different types of tools for cutting the shotcrete. How do you maintain a plum wall with the shotcrete rods? When a project requires a smooth finish or steel trowel finish, what are the tools and processes that are typically used? Finally, for a structural wall, what is the typical psi (MPa) and size of aggregate used?

Answer: The face or surface of shotcrete walls as described are typically established with ground wires or screeds, which assist the person using the shotcrete rod in cutting the wall to the proper plane. The tools typically used to achieve a troweled

surface are the shotcrete rod, wood floats, and steel trowels. Typically, shotcrete walls are a minimum of 4000 psi (27.6 MPa) 28-day compressive strength and the aggregate varies from sand only to a blend of sand and 0.375 to 0.5 in. (9.6 to 13 mm) aggregate. Consult our Shotcrete magazine archives for examples at **www.shotcrete.org**.

Question: In regards to the strength of shotcrete and weather is there a Mine Safety and Health Administration (MSHA) regulation requiring our paste cylinder sample results to be above a certain psi (MPa)?

Answer: Shotcrete is normally expected to meet or exceed 4000 psi (27.6 MPa). We are not aware of any specific MSHA requirements. We would suggest you consult a tunnel or mining engineer who is well-versed with shotcrete. Cores taken from field-shot test panels are generally used for the evaluation of compressive strength of shotcrete (ASTM C1140/C1140M-11).

Question: We plan to use fiber-reinforced (polypropylene fibers) shotcrete as a brown coat for stucco (three-coat stucco) over a concrete shear wall. Does a maximum thickness of 1.5 in. (38 mm) of shotcrete require any mechanical anchor/connection, or is the bonding strength of the shotcrete layer to the concrete shear wall substrate sufficient?

Answer: The addition of fiber will not increase the bond of shotcrete to the concrete shear wall. A 1.5 in. (38 mm) thick layer of properly designed and applied shotcrete should have adequate bond to a properly prepared concrete substrate without additional mechanical anchors. However, exposure conditions, geometry of the wall, shrinkage potential of the shotcrete mixture, application technique, and curing—as well as the age and quality of the shear wall concrete substrate—may affect the bond. These factors should be considered by an engineer experienced with shotcrete overlays in deciding whether additional anchoring is advisable.

Please note: *ASA's technical team provides the answers to submitted questions as a free service. The information is based on the personal knowledge and experience of the ASA technical team and does not represent the official position of ASA. We assume that the requester has the skills and experience necessary to determine whether the information ASA provided is appropriate for the requester's purposes. The information provided by ASA is used or implemented by the readers at their OWN RISK.*

Shotcrete Calendar

FEBRUARY 24-27, 2013
2013 SME Annual Meeting & Exhibit and CMA 115th National Western Mining Conference
Theme: "Mining: It's About the People"
Colorado Convention Center
Denver, CO
Website: **www.smenet.org**

MARCH 20-22, 2013
ICRI 2013 Spring Convention
ICRI Celebrates Its 25th Anniversary!
TradeWinds Island Resorts
St. Pete Beach, FL
Website: **www.icri.org**

APRIL 13, 2013
ASA 2013 Spring Committee Meetings
Hilton & Minneapolis Convention Center
Minneapolis, MN

APRIL 14-18, 2013
ACI Spring 2013 Convention
Theme: "Responsibility in Concrete Construction"
Hilton & Minneapolis Convention Center
Minneapolis, MN
Website: **www.concrete.org**

JUNE 9-12, 2013
ASTM International Committee C09, Concrete and Concrete Aggregates
JW Marriott Indianapolis
Indianapolis, IN
Website: **www.astm.org**

OCTOBER 19, 2013
ASA Fall 2013 Committee Meetings
Hyatt Regency & Phoenix Convention Center
Phoenix, AZ

OCTOBER 20-24, 2013
ACI 2013 Fall Convention
Theme: "Innovation in Conservation"
Hyatt Regency & Phoenix Convention Center
Phoenix, AZ
Website: **www.concrete.org**

DECEMBER 8-11, 2013
ASTM International Committee C09, Concrete and Concrete Aggregates
Hyatt Regency Jacksonville Riverfront
Jacksonville, FL
Website: **www.astm.org**

REED Mine 30–Mini Pump with Big Performance

REED's extremely compact Mine 30 Pump was designed for job sites with very limited space: 96 in. (2438 mm) long x 46.5 in. (1181 mm) wide x 64.7 in. (1643 mm) tall. The concrete, grout, and shotcrete pump is small enough to be cross-mounted on a truck or other carrier. Fork channels on the side and end come standard.

REED's "S"-Tube allows for pumping grout, flowable fill, pea-gravel concrete, shotcrete mixtures, and "big rock" concrete with aggregates up to 1.5 in. (38 mm). The Mine 30 Pump offers a maximum output of 30 yd^3/h (23 m^3/h) and 1172 psi (8 MPa) concrete pressure.

The Mine 30 Pump can be powered by an electric, diesel, or air motor. The simple design of the Mine 30 Pump makes it easy to troubleshoot and service. It provides strong performance, extreme dependability, and long life of all wear parts.

For more information on the New REED Mine 30 Pump, visit **www.reedpumps.com** or e-mail mike.newcomb@reedmfg.com.

Putzmeister America Expands Thom-Katt Line

The evolution of Allentown Shotcrete Technology's well-known Powercreter brand into the new TK 7 and TK 20 Thom-Katt trailer-mounted concrete pumps by Putzmeister America Inc., marks a significant expansion in Putzmeister's Thom-Katt product offering, which will now accommodate a wider range of outputs for specialized industries.

Originally manufactured by Allentown, the Powercreter brand has been re-engineered since having been acquired by Putzmeister in 2007. The new design is reflected in the TK 7, which will be available for purchase in 2013, and the TK 20, which was introduced in fall 2010. The updated models incorporate parts and components commonality, and can handle a wider variety of mixture designs for various applications.

"Previous Powercreter models were already using many parts from Putzmeister, so the transition into the Thom-Katt line was a natural one," said Patrick Bridger, President of Allentown. "While the proven performance of the Powercreter is still there, the new models use the sturdy Thom-Katt frame and familiar Thom-Katt control box."

The new TK 7 is a compact, skid-mounted, electric-powered pump for precise control of low-volume shotcrete, form-and-pump, and grouting applications.

Features of the new TK 20 include an optional, detachable 13 ft^3 (0.4 m^3) capacity mixer. The mixer adds the ability to use prepackaged concrete mixtures on site, or can be detached for feeding the pump with ready mix concrete.

For more information, call (800) 553-3414 or visit **www.putzmeisteramerica.com**.

Putzmeister Showroom Opens in Bahrain

MH Al Mahroos, a Bahrain-based industrial and engineering equipment trading company, has opened a new service center and show room for Putzmeister, a leading manufacturer of concrete and material placing equipment headquartered in Germany.

The new Putzmeister showroom was inaugurated at MH Al Mahroos' premises in the presence of Sabine Taufmann, the German Ambassador to Bahrain, and Dr. Robert Abel, the CCO of Putzmeister Concrete Pumps, Germany.

This event is a quality step to promote Putzmeister concrete and mortar pumping solutions in Bahrain on par with international standards, said Abel.

"Putzmeister, along with its Bahrain partner MH Al Mahroos, is committed to provide customers with best-quality after-sales service through a high-tech service center, mobile service stations, on-shelf stock of spare parts, factory-trained engineers, and technicians," he stated.

"We are looking forward to serving the Bahrain construction market with our joint services from now on. Putzmeister strongly believes in the Bahrain market; thus, it was essentially important to invest in a Service Centre specifically designed to handle Putzmeister products with all the latest technologies," said Abel.

Putzmeister, he said, was a specialist in manufacturing high-quality concrete pumps, truck mixers, plastering machines, screed conveyers, and mortar machines.

"We always focus on satisfying customers' needs by providing immediate after-sales service and spare parts supply to support Putzmeister's growing ambitions. We also have planned to add more facilities like a training center for operator trainings," explained Abel.

MH Al Mahroos and Putzmeister will be providing, under one roof, the complete service to ready mix companies right from pumps, plastering equipment, transit mixers and more to come, he added.

—TradeArabia News Service

BASF launches new Construction Centre in Canada

BASF's Construction Chemicals division has announced the grand opening of its new Construction Centre in Toronto, ON, Canada. A celebratory event was hosted at the site for more than 100 construction contractors, distributors, architects, and engineers in the greater Toronto area.

"The new BASF Construction Centre will service the Greater Toronto Area and the Canadian marketplace and will continue to build on BASF's leadership position and commitment to providing product and system solutions to solve even the most demanding job-site challenges in the construction industry," said John Salvatore, Head of BASF Construction Chemicals Americas.

The BASF Construction Centre offers on-site customer service and support, manufacturing and warehousing capabilities, and is centrally located to ensure optimal service to BASF's construction partners in the industry. Additional benefits include increased service to the Canadian marketplace and enhanced distribution and logistics to deliver products on time.

The BASF Construction Centre will feature a full line of products from the Construction Chemicals business. "With the opening of the Construction Centre, we are reinforcing our commitment to serving the needs of construction professionals in the Canadian marketplace," said Brian Denys, Head of BASF's Construction Systems business.

For more information, visit **www.basf-admixtures.com**.

ICC-ES ESR#1165 Verifies that Fibermesh Meets Code Requirements

Fibermesh® 150 and Fibermesh 300, manufactured by Propex, recently received an evaluation report (ESR#1165) from ICC Evaluation Service (ICC-ES), providing evidence that these microsynthetic concrete fiber reinforcements meet code requirements. Building officials, architects, contractors, specifiers, designers, and others use ICC-ES Evaluation Reports to provide a basis for using or approving Fibermesh in construction projects under the International Fibrous Reinforcing Code.

ICC-ES President Shahin Moinian explains why ICC-ES Evaluation Reports are so important. "Propex can now reference the evaluation report to ensure building officials and the building industry that the product meets I-Code requirements," Moinian said. "Building departments have a long history of using evaluation reports, and ICC-ES operates as a technical resource with the highest quality of product review for the building department. Final approval of building products is always in the hands of the local regulatory agency."

ICC-ES thoroughly examined Propex's product information, test reports, calculations, quality control methods, and other factors to ensure the product is code-compliant.

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

Strata Chamber Receives First Component of Part 7 MSHA Approval

The Strata Worldwide Breathable Air Component used in its portable Fresh Air Bay mine refuge chamber has received U.S. Mine Safety and Health Administration (MSHA) approval.

The Fresh Air Bay Breathable Air Component is one of a series of design modifications Strata is making to the Fresh Air Bay design to meet MSHA's new chamber regulations as specified in Part 7 of the Title 30 Code of Federal Regulations.

The approved Breathable Air Component is an element of the proprietary breathing air system standard in all Strata Fresh Air Bays. This breathing air system provides chamber occupants with 96 hours of breathable air in the event of an emergency that prevents escape from the mine.

Fresh Air Bay is an inflatable mine refuge chamber that is deployed in post-accident situations to provide miners trapped underground with breathable air and other life-sustaining provisions while they await rescue.

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

King Packaged Materials Company Makes Social Media Debut

Effective immediately, the King Packaged Materials Company can be found on Facebook by searching for "King Packaged Materials Company," "Construction & Masonry Products," or visiting **www.facebook.com/KPMIndustriesLtd**. The move to include this social media outlet in its marketing mix will allow the construction products division and the masonry group to actively engage with various audiences on the web. This strategic decision also reflects the growing web presence of many companies within the prepackaged cementitious products industry, and the overall trend toward technological advancement within the construction products market.

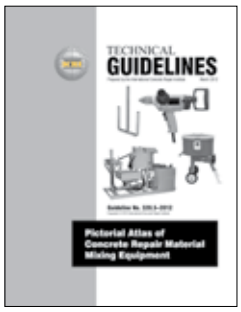
The addition of Facebook will allow users to retrieve product information and those resources currently featured on the construction products website, **www.kingshotcrete.com**. Facebook will not likely be the only social media platform used by King Packaged Materials Company, as the company plans to add other social media outlets to its online suite in 2013. For more information on the company social media initiatives, please contact Shannon Polk at spolk@kpmindustries.com.

Edwin Brady Construction Debuts New Website

Edwin Brady Construction Co., Inc., has announced a recent update to their website. The new site presents an extensive overview of both the company in general and its President, Edwin Brady, PE, with case histories of projects, categorized by different types of work, awards received, and links to published articles—all with numerous photos. The organization has received positive feedback and continues to experience increased visits. The site will be continually updated to reflect new information.

Visit the website at **www.edwinbradyconstruction.com** for more information.

ICRI Announces Pictorial Atlas of Concrete Repair Material Mixing Equipment



The intent of this Technical Guideline is not to advocate one type of paddle or piece of equipment versus another, discuss mixing efficiency, or other properties, but simply to provide a single-source common guide that can be used in the trade when describing or specifying mixing equipment. Specifying equipment for mixing concrete repair materials is extremely difficult because the industry uses multiple names for the same equipment and the same names for different equipment. The problem has been that different types of mixing paddles and mixers can produce different consistencies and properties in concrete repair products. ICRI sees this guide as the solution, as it will help ensure the appropriate equipment is properly described or specified.

This ICRI Technical Guideline is only available for purchase as a downloadable PDF file from the ICRI website at **www.icri.org**.

QUIKRETE Wet Process Shotcrete

The QUIKRETE® Companies' latest innovation, QUIKRETE Wet Process Shotcrete, was recognized as a critical element in the award-winning Oregon Department of Transportation (ODOT) U.S. Highway 26 Dennis L. Edwards Tunnel Project in Portland, OR. More than 1200 bags of 3000 lb (1361 kg) QUIKRETE Shotcrete MS – Steel Fiber Reinforced was used in the tunnel renovation, which was named the 2011 "Outstanding Repair & Rehabilitation Project" by the American Shotcrete Association (ASA).

After 70 years of continuous vehicle traffic between Portland and the Oregon coast on Highway 26, the 772 ft (235 m)

Dennis L. Edwards Tunnel was in need of significant structural restoration. However, renovating the tunnel could not interfere with the daily commute of thousands and had to be completed before traffic doubled when the tourist season began in May 2011. To make the project even more challenging, the general contractor, Johnson Western Gunite Company, faced wet weather and unstable ground conditions when the project started in January 2011. This made the use of a traditional rock bolt

and shotcrete application system impossible, so an extremely unique approach was taken to restore the tunnel. QUIKRETE Shotcrete MS – Steel Fiber Reinforced was applied up to 18 in. (457 mm) thick between existing timber sets so lagging could be removed and reinforcement applied a section at a time. This process enabled construction to be performed safely and efficiently throughout the night.

In addition to exceeding project strength specifications by reaching 3800 psi (26 MPa) at 1 day and more than 9400 psi (65 MPa) at 15 days, the QUIKRETE Wet Process Shotcrete limited dust in the application process by batching the shotcrete wet in advance rather the combining the water and shotcrete during the shooting process. As a result, there was little cleanup each morning in preparation for traffic, and Johnson Western Gunite Company completed the project on time.

The QUIKRETE Companies offers a full line of shotcrete products that can be applied through a wet or dry process to deliver high strength, high adhesion, low rebound, and low sag in rehabilitating bridges, tunnels, parking garages, ramps, piers, dams, and other concrete structures. In the past decade, QUIKRETE shotcrete has been used on a variety of renovation projects ranging from the Stanford Linear Accelerator in California and the New World Symphony in Florida to the Ashton Hydro Electric Plant in Idaho and Rankin Bridge in North Carolina.

For more information on QUIKRETE and its products, visit **www.quikrete.com**, like it on Facebook, and follow it on Twitter @QUIKRETE.

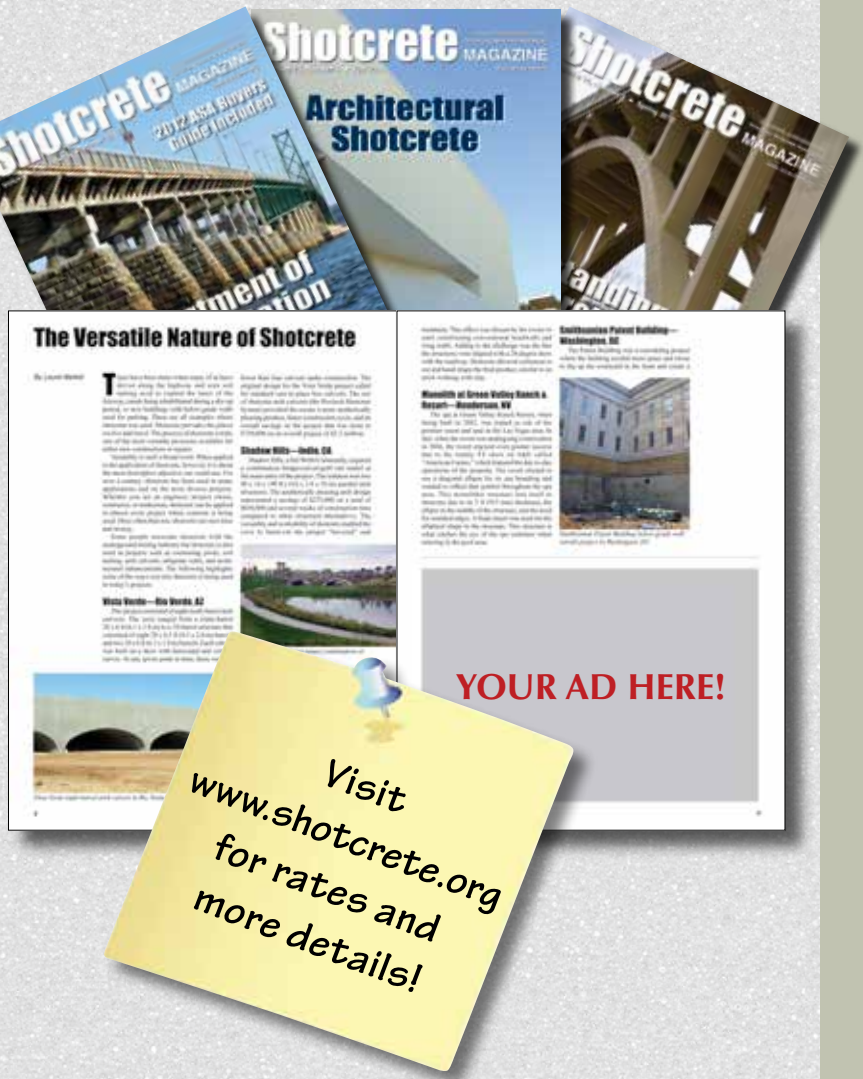
Shotcrete

2013 MEDIA KIT

A quarterly publication of the American Shotcrete Association

MAGAZINE

TARGET THE SHOTCRETE WORLD WITH YOUR COMPANY'S PRODUCTS AND SERVICES!



Advertising in *Shotcrete* magazine is the most affordable and effective way to reach the shotcrete industry. Each issue of *Shotcrete* magazine reaches a growing number of **over 17,000 readers** that include current and potential designers, specifiers, and purchasers of shotcrete in over 100 countries.

Our streamlined rate charts make choosing the right advertising option for your company easy. Rates remain the same as 2012 in 2013.

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Direct your orders or questions to: info@shotcrete.org or 248-848-3780

Fibermesh®

Concrete Solutions by Propex

Explosive Problem.

Explosive Spalling

As the world's most widely used construction material, concrete offers many advantages to building and civil engineering projects, including versatility, strength, and durability. However, it is known to present problems when exposed to high-temperature fires.

Several major tunnel fires, including the Channel Tunnel (1996), Mont Blanc (1999), Kaprun (2000), and Gotthard (2001), have raised questions about the properties of concrete in fire situations and prompted much research into its behavior at high temperatures. Investigations into fires in concrete structures have determined that a significant loss of cross-sectional area in the tunnel lining can occur due to the explosive spalling of concrete when exposed to very high temperatures.

Explosive spalling occurs when moisture in the concrete is heated faster than it can migrate from the heat due to a rapid temperature rise, as in hydrocarbon-fueled fires. As the heat of the concrete increases, moisture in the concrete pores experiences a phase change to vapor. This vapor causes an increase in pore pressure, which is unable to escape from the concrete mass. As this process continues, vapor pressure rapidly builds up and exceeds the tensile capacity of the concrete, causing explosive spalling.

Effective Solution.

Fibermesh® 150

Fibermesh® Concrete Solutions by Propex has spent many years researching how micro-polypropylene fibers function in concrete when exposed to fire. We have built up a very detailed understanding of the mechanism by which certain types of fiber can provide this valuable function.

This research knowledge has been used to develop Fibermesh 150, a quality-assured fiber that provides the highest performance against explosive spalling yet, at the same time, is user-friendly to the concrete producer and contractor.

Unlike several other competitors' fibers that are offered for this application, Fibermesh 150 has minimal effect on both the workability and air content of the concrete.

Incorporating a relatively small amount of Fibermesh 150 fiber provides a three-dimensional protection system throughout the concrete and ONLY when there is a fire do they create the correct form of permeability that is required to relieve the steam pressure that is created inside the concrete. Despite the claims of some manufacturers, it is not only the number of fibers that determines how much resistance to explosive spalling is provided but also the optimized balance of the best type of fiber and the number of fibers—and that has been built into Fibermesh 150.

The ability of Fibermesh 150 fibers to prevent explosive spalling of concrete has been independently verified at several internationally renowned fire test laboratories, including SP Technical Research Institute (Sweden), Efectis/TNO (the Netherlands), IBS (Austria), Hagerbach Test Gallery (Switzerland), and BRE (United Kingdom).

Fibermesh 150 microsynthetic fibers are manufactured to ISO 9001 Quality Assured Standards from 100% virgin polypropylene containing no reprocessed materials and are engineered specifically for use as concrete reinforcement. Fibermesh 150 microsynthetic fibers are European Standard EN 14889-2:2006 compliant and carry CE marking.

In addition to providing explosive spalling resistance, Fibermesh 150 fibers will provide resistance to early-age shrinkage cracking, improve impact and abrasion resistance, and reduce rebound in sprayed concrete applications.

Explosive spalling in concrete creates three main consequences:

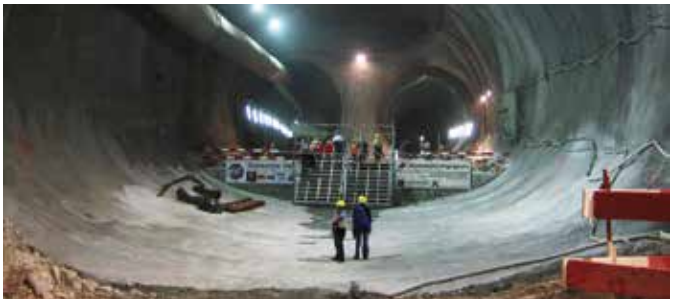
1. A health and safety risk for the emergency services;
2. The structural integrity of the tunnel is placed at risk; and
3. Huge economic damage caused by major disruption and enormous repair costs.

Fibermesh® Concrete Solutions By Propex
6025 Lee Hwy
Chattanooga, TN 37421-3099
(423) 553-2245
www.propexglobal.com

Corporate Member Profile

Gotthard Base Tunnel, Switzerland

The Gotthard Base Tunnel, with a length of 35 miles (57 km), will be the longest tunnel in the world upon completion in 2015. Fibermesh 150 fibers were tested and approved for use on this project at the world-renowned Hagerbach Test Gallery in Sargans, Switzerland. Since commencement of the project, Fibermesh 150 fiber at a dosage of 3.4 lb/yd^3 (2 kg/m^3) has been the preferred fiber of contractors on various sections of this $12.5 billion (11.7 billion Swiss Franc) project.



Melbourne, Australia

In keeping with the focus on safety, tunnel engineers specified the inclusion of Fibermesh 150 fibers at a dosage rate of 3.4 lb/yd^3 (2 kg/m^3) in both shotcrete and cast-in-place tunnel linings for this twin-bore 1 mile (1.6 km) long road tunnel. Fibermesh 150 fiber was chosen in preference to other fibers because of its certified performance and because it did not adversely affect the workability and air content of the concrete. Joint Venture group—Theiss John Holland were the contractors on this $3.8 billion project.

CTRL, United Kingdom

This $200 million (£130m) project is part of the Channel Tunnel Rail Link (CTRL) high-speed rail link, which runs for 67 miles (108 km) between the Channel Tunnel and central London. The project has over 25 miles (40 km) of 23.5 ft (7.15 m) diameter, precast-concrete-lined bored tunnels—sections that are constructed in water bearing sand. Fibermesh 150 fibers at a dosage of 1.7 lb/yd^3 (1 kg/m^3) were used in the production of the precast tunnel lining segments, which also included Novocon steel fibers in a total fiber-reinforced solution.

Weehawken Tunnel, New Jersey, USA

Tunnel engineers Parsons Brinkerhoff selected the use of Fibermesh 150 fibers for the tunnel lining on the Weehawken twin-track light-rail project in preference to other fiber products after establishing that they did not adversely affect the level of air entrainment within the specified concrete. Fibermesh 150 fibers were used at a dosage rate of 2.0 lb/yd^3 (1.2 kg/m^3). Novocon steel fibers were also used to increase the flexural toughness of the tunnel lining.

Vomp Terfens, Austria

This 5 mile (8.4 km) two- and three-track rail tunnel in the Austrian Tyrol forms part of the main Munich to Verona railway line and is the longest NATM tunnel in the Brenner axis upgrade project. Joint Venture group—Zublin AG, Hoctief AG & Strabag Bau-AG selected Fibermesh 150 fiber for the passive fire protection of the final tunnel lining after conducting extensive fire testing and concrete mixture trials. A dosage rate of 3.4 lb/yd^3 (2 kg/m^3) was specified by the project engineers.

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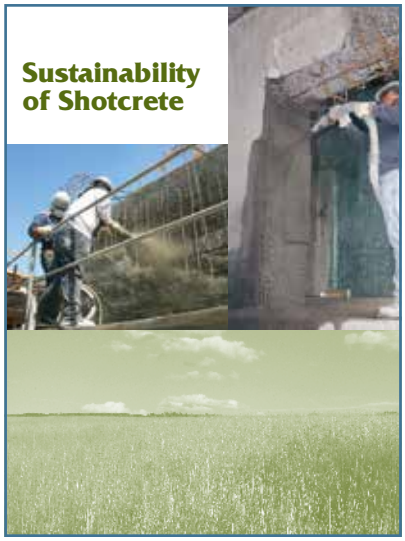

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