Shotcrete

A quarterly publication of the
American Shotcrete Association

MAGAZINE

Volume 14, Number 3 ◆ Summer 2012

www.shotcrete.org

Water Features

AMERICAN
SHOTCRETE
ASSOCIATION


'KING PROVIDES US WITH SOLID SUPPORT.
EACH OF OUR PROJECTS IS UNIQUE - AND SO IS KING'S APPROACH TO SERVICE.'
- Eric Kohtakangas, VP Operations, Cementation Canada Inc.
Cementation

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

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Shotcrete MAGAZINE

Volume 14, Number 3
Summer 2012

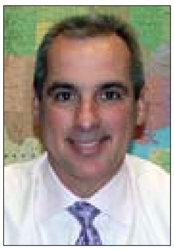
Features

Departments

On the cover: Negative edge swimming pool in Auburn, CA, built by Gyori Development Corporation. Photo courtesy of Gyori Development Corporation

Certification Matters

By Joe Hutter



I read with great interest an article that was written by one of our respected members in the March 2012 issue of *World Tunneling* magazine. In the article "Behind the Nozzle," Ed Brady asks, "How can we attain the highest standards of workmanship and who is best placed to attain them?" The answer to this question can often be found before a project is even awarded—in a well-written specification.

A good specification will identify a number of important key elements of the shotcrete process, among the most important being the use of an ACI Certified Nozzlemen. The role of ACI certification, however, can sometimes be misunderstood. The certification program has definitely helped identify if a nozzleman possesses a minimum level of compentency, as defined by the ACI program. Also, most people agree it has improved the overall skill level of shotcrete nozzlemen. The certification program does not, however, provide any guarantees when it comes to application quality. Certification simply confirms that a nozzleman has the ability to properly encapsulate reinforcing bar (using one or both shotcrete processes) in a vertical and/or overhead orientation.

ASA played a significant role in the development of the ACI Shotcrete Nozzleman Certification Program. The program's success is evident in that almost 2000 ACI nozzlemen certifications have been issued since the program's inception at World of Concrete 2001.

Regardless of experience and qualifications, an ACI Certified Nozzleman is only one of many parts required to ensure a successful shotcrete project. In other words, the shotcrete process is not an individual effort—it is a team effort that requires the cooperation of a number of vital team members.

One of the most overlooked aspects of a successful shotcrete program is the prequalification of the shotcrete contractor. Including contractor prequalification in the specification before the project is released for tender is always a good place to start. The prequalification process should identify shotcrete contractors who have demonstrated their capabilities through a history of successful high-quality shotcrete projects, and specifiers should ensure that only those contractors submit proposals for shotcrete placement. Allowing a general contractor to "learn the shotcrete ropes" on a specific job is a recipe for trouble, even if the contractor has made the effort to employ an ACI Certified Nozzleman.

Project references should always be checked before awarding a contract to verify that the contractor's previous projects display the characteristics of successful long-term shotcrete application. In a case where the shotcrete work is being subcontracted, the shotcrete subcontractor should also be placed under the same scrutiny.

ASA has taken a leading role in providing access to many of North America's most successful shotcrete contractors through the development of the "ASA Buyers Guide." A link to the guide is available through the ASA Web site, allowing anyone to search for a shotcrete contractor using project-specific or geographical criterion.

ASA has also developed an Online Project Bid Submittal Tool so that owners who have interest in tendering a shotcrete project can do so through ASA and access ASA's full roster of member contractors.

ACI certification was the first big step taken toward improving the quality of shotcrete placement, and ASA is very proud of its role in the development of the nozzleman certification program. Specifiers should understand, however, that certification is only one ingredient in the recipe for a successful project. A qualified shotcrete contractor will provide an experienced team of professionals; and if the specification demands prequalification, our industry will be one step closer to attaining the highest standards of workmanship we all seek!

www.shotcrete.org RESOURCE REMINDER

Check out ASA's Buyers Guide
http://shotcrete.org/BuyersGuide/index.asp

Submit a Project for Bid
http://shotcrete.org/ProjectBidRequest.aspx

Interested in Certification
http://shotcrete.org/ASAcertification.htm

Greetings from Your New ASA Safety Committee Chair!

By Oscar Duckworth

I make my living as a professional nozzleman. I have logged more nozzle time than most. I have seen the good, the bad, and the lucky. I have been injured and I have seen others get injured. Safety is a critical issue in all industries, but I know firsthand that this is especially true in the shotcrete industry.

In short, the ASA Safety Committee's work is to promote safe practices. This is accomplished at two levels. The first is its very broad role as the association's primary resource for safety information and to review all of the association's materials. The second is its accomplishment of work through a number of safety-specific initiatives.

The first and most obvious effort appears in each issue of this magazine. The Safety Shooter feature provides a forum for the ASA Safety Committee to address and comment on timely and important safety issues in our industry. My responsibilities as ASA's Safety Committee Chair include the assurance that this feature will regularly address safety at the work level—that is, the machinery, the couplings, and endless list of small things that are often overlooked. Relevant, informative articles from the shotcrete worker's perspective will continue to be brought forward with the ultimate goal of making the job site safer for everyone.

Another important and exciting effort underway is the committee's work to develop a new safety document. Through countless hours of volunteer effort, a comprehensive safety resource for our industry is on the near horizon. Content is being finalized and a number of delivery mediums are being explored, with a printed manual and DVD among the possible options. This initiative and the association's significant investment of resources to the effort reflects ASA's deep commitment to safety.

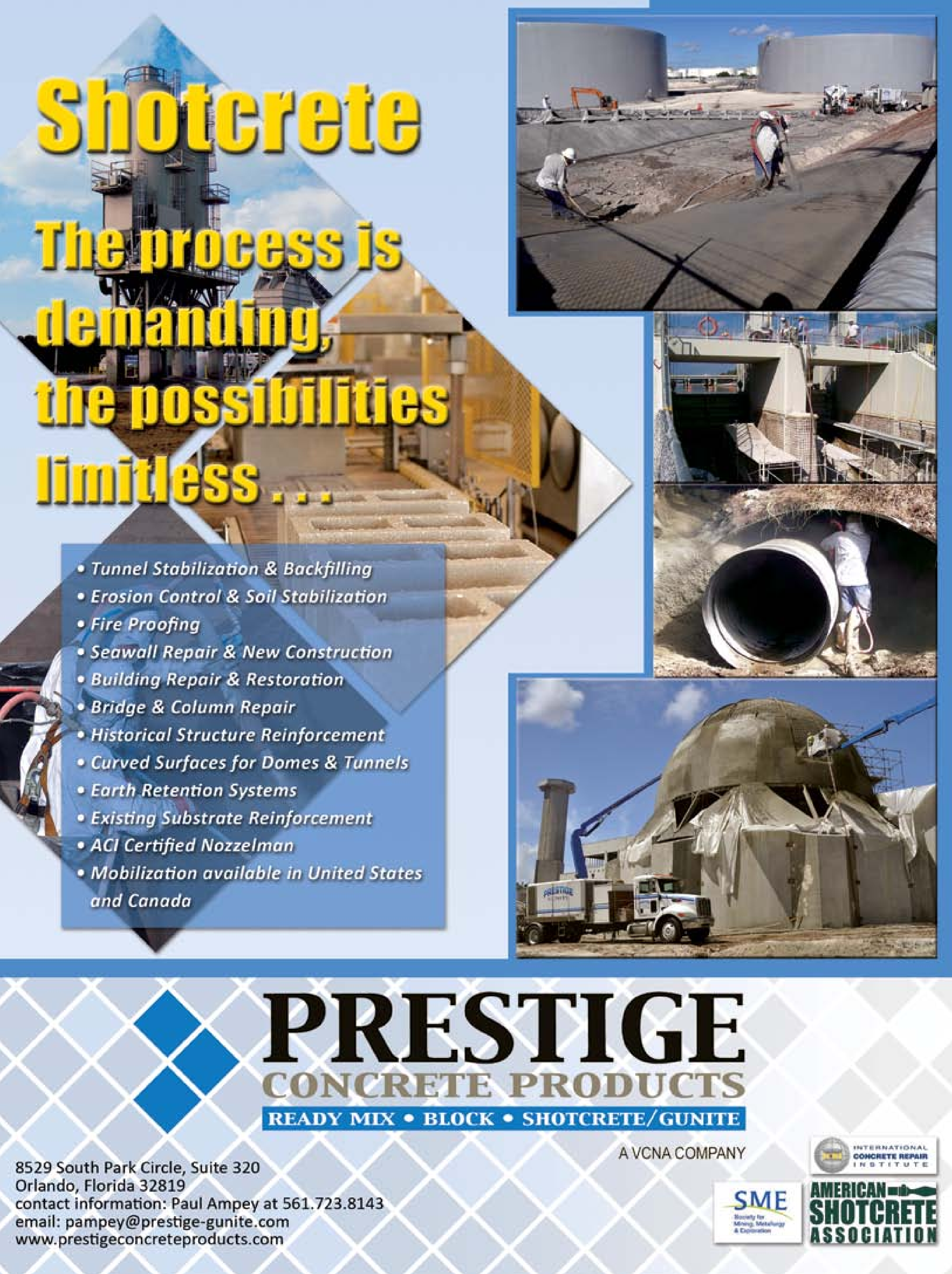
Do you have a knowledge of and experience with shotcrete safety and related issues? Do you have an opinion on these items and a desire to continually improve safety within our industry? If so, ASA needs your participation in its Safety Committee. ASA committee meetings take place three times a year, are open to the public, and require no registration fee. I hope you will consider participating in our next meeting scheduled for Saturday, October 20, 2012, in Toronto, ON, Canada.

As a consensus group, we can accomplish many things and have a very positive impact on our shotcrete industry.

ASA Safety Committee

Oscar Duckworth, **Chair** | *Valley Concrete Services*
Andrea Scott, **Co-Chair** | *Hydro Arch*

Patrick Bridger | *Putzmeister Shotcrete Technology*
Roberto Guardia | *Shannon & Wilson*
Charles Hanskat | *Hanskat Consulting*
Warren Harrison | *W.L.H. Construction Company*
Ron Lacher | *Pool Engineering Inc.*
Dan Millette | *The Euclid Chemical Company*
Dudley R. "Rusty" Morgan | *Consultant*
David Morowit | *Acorn Concrete Pumping*
Ryan Poole | *DOMTEC International LLC*
Raymond Schallom III | *RCS Consulting & Construction Co., Inc.*
Ted Sofis | *Sofis Company Inc.*
Marcus H. von der Hofen | *Coastal Gunite Construction Company*
Lihe (John) Zhang | *LZhang Consulting & Testing Ltd.*


Shotcrete
The process is demanding, the possibilities limitless . . .
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An Exciting New Corporate Member Benefit—Are You Receiving It?

By Chris Darnell, ASA Executive Director

It's no secret. Our Corporate Members are at the heart of ASA, and we continue to work hard to create and maintain significant benefits for this group. Many benefits—too many to review here—accompany an ASA corporate membership. Typically, these benefits fall into one of two categories: short-term or long-term.

The long-term membership benefits tie in closely to the overall strategies that ASA is engaged in to grow the percentage of concrete placed via the shotcrete process. Examples include promotional and educational efforts at trade shows and strategic involvement in organizations such as the American Concrete Institute (ACI) and AASHTO's TSP·2. The goal of long-term benefits is to grow the shotcrete industry and increase the potential growth of our Corporate Members' businesses.

The short-term benefits are intended to provide a more immediate return for our Corporate Members in the form of cost savings and/or specific project work. These include significantly reduced member pricing on education/certification sessions; potential job leads, which appear in the member edition of ASA's bimonthly e-newsletter "What's in the Mix"; and an online listing of each Corporate Member in the "ASA Buyers Guide," which receives over 7000 searches a year.

An exciting new short-term Corporate Membership benefit has recently been incorporated into the ASA Web site that gives owners and specifiers the option to submit their shotcrete project for bid by ASA Corporate Members (**www.Shotcrete.org/ProjectBidRequest.aspx**). This resource was developed in response to recent conversations we had with numerous officials at trade shows and meetings. Some of these officials had posted shotcrete projects and not received a single serious bid request. This new resource is designed to help ensure shotcrete specifiers always have access to those who can provide the shotcrete equipment, material, and/or construction expertise required.

When ASA receives a bid request, an e-mail alert is immediately sent to all of our Corporate Members with the subject line: "**ALERT: ASA Corporate Member Bid Request—Please Read**." The body of the notice includes details of the project, contact information, and a deadline for bid submission.

The initial response from the construction world has been very positive, with a number of bid requests already received and processed. For this resource to succeed, however, we need our Corporate Members to be aware when bid requests are generated and to respond when a project is appropriate for their business.

To grow this exciting benefit for both the construction industry and ASA Corporate Members, please do the following: *If you are a current ASA Corporate Member, PLEASE make sure we have your current e-mail address and that ASA is not on your blocked list*.

Rest assured that ASA will not give your e-mail address to other organizations and will only send you a maximum of two e-mails (in addition to these bid requests) each month. We highly value and respect e-mail addresses and pledge not to abuse that access.

With your help, this bid request tool will grow into a unique resource that not only benefits our members but also owners and specifiers. It will provide them access to ASA's outstanding Corporate Members and the exceptional level of quality and benefits that only a shotcrete process executed by experienced and quality-committed organizations can provide.

Special Notice

ASA Education Sessions for the ACI Shotcrete Nozzleman Certification program to be offered

ASA Education Sessions will be offered at the International Pool & Spa Show this November in New Orleans, LA, and in February at World of Concrete 2013 in Las Vegas, NV.

Attending an ASA Education Session is required for all nozzlemen planning to pursue ACI Certification through an ASA Certification session. Attending either of these two sessions will satisfy the ASA prerequisite and allow attendees to pursue ACI Certification through a separate ASA Certification session. Certification sessions are typically coordinated by a contractor and hosted on site. Certification sessions also include written and performance exams.

These Education Sessions will also be a great learning opportunity for nozzlemen who have not yet attained the 500 hours of nozzling experience, which is an ACI prerequisite to qualify for participation in the Shotcrete Nozzleman Certification program.

While ACI Certification cannot be attained by only attending either of these education sessions, participation in an ASA Education Session is required to become an ASA Nozzleman Member. By attending either of these two ASA Education sessions, you will receive a complimentary 1-year ASA Nozzleman membership.

For more information on these upcoming Education Sessions, please refer to the Association News section of this magazine on page 60 or visit the ASA Web site at **www.shotcrete.org**.

The Evolution of the Swimming Pool

By Paul F. Ampey

"Pool is a pool is a pool is a pool." Actually, the correct words are, "Rose is a rose is a…" and so on. The line, from Gertrude Stein's poem "Sacred Emily," written in 1913, was intended to propose that "once there, a thing (such as a rose or pool) is what it is and will always be there."

In ancient times, the term "pool" was known as "thermae," which meant a public bathing establishment. The oldest thermae systems in the world date back to the second century before the Christian era with construction of the Stabian Baths of Pompeii, Italy (Fig. 1), which are the oldest and still exist today. The origin of the term "pool," however, goes back to the early Roman and Greek eras. It originally meant a container of water that functioned as a potable water storage tank used as a fish hatchery or a place to swim. In the Roman house, the pool was the impluvium that collected rainwater and, on a larger scale, pools formed part of an aqueduct system for collecting and distributing water throughout major cities. Lastly, the thermae of cities were public bathing establishments known as "natatoriums." Architecturally, they consisted of a large central space with vaulted ceilings, heated by steam and surrounded by smaller rooms, decorated with marble or mosaics.

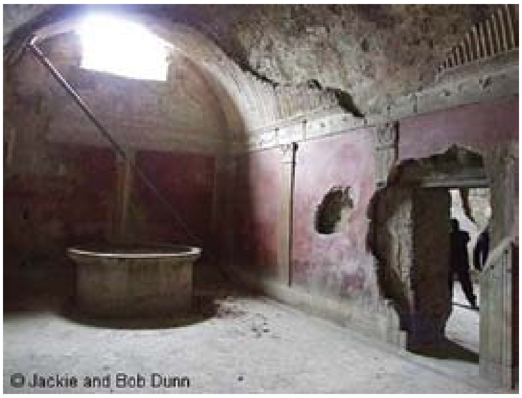

Fig. 1: Historical Stabian Bathes, Pompeii, Italy


Fig. 2: LaCourone Garden, seventeenth century

Over time, pools have served as a place for recreation and cleanliness as well as a place to stimulate genuine physical and psychological well-being. Garden pools of the seventeenth century were constructed in domestic settings designed for visual and auditory enjoyment for persons seeking a source of reflection and inspiration. These pools may have been the first "backyard" variety (Fig. 2). Pools have evolved in many ways and uses. Today, water as a source of health plays the starring role.

Although water covers 70.9% of the Earth's surface, humanity is continually building structures to encompass it for use on land to quench its need for recreation, exercise, competition, and relaxation. Today's swimming pool contractor takes into account many factors in the design and construction of water features. First and foremost, the client: what is their need and purpose? Today, our planet is dotted with water theme parks (Fig. 3), commercial and residential pools, and spas—all to service these needs.

Once the purpose is identified, the design takes place and materials are chosen. One of the major components of a pool is the shell; the majority of shells are constructed with concrete. Concrete, made from mud, straw, and water, has been around for about 10,000 years and the earliest pool shells


Fig. 3: Rapids Water Park, West Palm Beach, FL

Fig. 4: Batching truck with rotary gun for dry-mix application

were also fabricated from it. The process of pneumatically placing a mortar mixture onto various surfaces with a high-velocity "cement gun" was invented in 1907 by Dr. Carl E. Akeley. The term "gunite" was patented and the creation of the Cement Gun Company (now known as Allentown Equipment) began. During the 1930s, American Railway Engineers introduced coarse aggregates to the process and described it as "shotcrete." Although the term "gunite" will probably always be with us, the industry is slowly recognizing both processes as "shotcrete—wet or dry." Shotcrete can be considered a contemporary method that has become highly significant in today's swimming pool construction industry because of its flexibility and ease of placement. The materials used in both wet- and dry-mix processes are generally the same as those used in conventional concrete placement—portland cement; supplemental cementitious materials (microsilica, fly ash, and slag); aggregates; and water, with the difference being that compressed air is introduced in the application process.

The "dry" process is sand (the aggregate) and cementitious content that is delivered via an auger mixing method into a gun where compressed air is introduced, blowing the material through the hose to the nozzle where hydration takes place. The nozzlemen controls the addition of water depending on the application needs (Fig. 4).

All the ingredients in the "wet" method (aggregates and cementitious content), including water, are pre-mixed thoroughly and introduced into the delivery equipment. Typically it has been a concrete pump that pushed the mixture through a hose to the nozzle where compressed air is injected, again controlled by the nozzleman as he/she directs the material into place (Fig. 5).

The *placement* process of shotcreting solves a number of construction challenges. First, the manner for excavation of the pool is subject to soil stability. The Prestige Concrete Products crews of Sacramento, CA, where soil conditions are more stable, generally apply shotcrete onto


Fig. 5: Wet-mix concrete delivery truck and pump, Peabody Hotel, Orlando, FL


Fig. 6: Spa construction, Peabody Hotel, Orlando, FL


Fig. 7: Dry-mix process with use of Steel Tex in the foreground. Residential lap pool, West Palm Beach, FL

the pool walls that follow the contour of the earth's excavated shape. In the state of Florida, our crews find that the pool contactors "over"-excavate the shape of the pool because of the sandy soil conditions and, with the use of exterior form boards, Steel Tex (prefabricated sheets of light wire mesh on a backing paper) and reinforcing bar, the contractor can produce almost any pool shape. In either case, both systems of forming are less labor-intensive, use less material, and therefore are more cost-effective (Fig. 6 and 7).


Fig. 8: Dry-mix process used for renovation, adding step and planters


Fig. 9: Dry-mix process used for fountain at a condominium, Ft. Myers, FL


Fig. 10: Residential pool in Granite Bay, CA

The *flexibility* of shotcrete in either process provides limitless use in complex shaping and forming in new construction and renovation projects. Depending on the project constraints, shotcrete is often quicker, less labor-intensive, and therefore less expensive than building with two-sided forms. Shotcreting also works well on several popular design elements, such as vanishing edges and family-friendly beach entries. With the strong relationship between the contractors, material suppliers, equipment suppliers, and the research community, advancements in shotcrete have increased dramatically. ACI Certified Shotcrete Nozzlemen expertly use both methods to safely and efficiently place the materials where traditional concrete placement (form and pour) is either too complicated or too costly (Fig. 8).

The continuing invention of new materials and construction systems have freed up our imagination to create, shape, and mold our environment. Architectural trends and developing construction standards have dictated the appearance of pools (Fig. 9 and 10). And although "Pool is a pool is a pool is a pool," the swimming pool industry has ardently embraced the opportunity to be creative and has "changed this thing, but yet it has still remained—a pool."

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*ASA member **Paul F. Ampey** is a Business Development Manager for Prestige Concrete Products—Shotcrete Division in South Florida. His research interests focus on aquatic and structural repair applications. He spent more than 20 years in several areas of civil construction, including 6 years with the U.S. Air Force as a Staff Sergeant with the Civil Engineering Prime Beef detachment as a heavy equipment operator and draftsman.*

Natural Fit

By Bill Drakeley

As I sat through a seminar highlighting contemporary organic architecture, the realization occurred that shotcrete construction is a seamless fit to this design philosophy. The principal of design of America's most famous architect, Frank Lloyd Wright, was that of organic architecture. These concepts were based on what nature creates. Wright's designs were to be site-appropriate with respect to their materials and surroundings. Form was to have function. It was not only to be functional but also efficient. John Lautner, a disciple of Wright, used this design principal as his foundation. Real architecture in Lautner's practice was that it is as it looks—real materials, real settings. The structural assemblies were not fake or made to look like something else. They were natural solutions to reduce the amount of energy needed or used (that is, stone, wood, wind, solar, glass, and so on). The shapes of structures were either straight or curved, based on client wants and needs. The architecture was a living space meant to fit within its natural surroundings.

Now, the question you may be asking yourself as you read this architectural rambling is, "What does this have to do with swimming pool shotcrete?" Frank Lloyd Wright, John Lautner, and Helena Arahuete (Lautner's apprentice and now head of Lautner Associates) all consider concrete to be a symbiotic and natural component of their structural designs. Concrete is an organic design material made with natural ingredients. Using the advanced technologies of shotcrete, architects and designers have almost unlimited freedom in the creative aesthetics of their concrete structures. Without the need of heavily reinforced two-sided forms, shotcrete completely removes many barriers on shape and thickness imposed by casting concrete members. Many of the evolving living space concepts created by innovative architects now use shotcrete as a means of placing materials, not only for structure but also for architectural looks. The first vanishing-edge swimming pool was built in the late 1950s and designed by John Lautner. The vanishing edge origin or concept, as described by Lautner, was a simple "continuation of space." Keeping this design concept prominently in mind, our company helped the design team on a current project realize a pool's potential with significant enhancements in overall scope. This article will describe the job evolution.

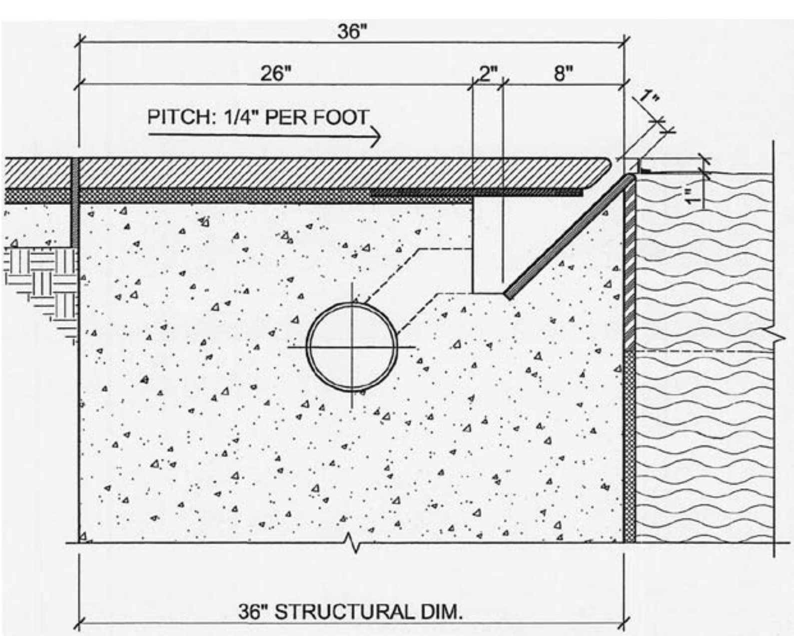


Fig. 1: Lautner edge section. Scale: 1.5 in. (38 mm) = 1 ft (0.3 m)

Redesign

This "continuation of space" premise is where the pool project shines. Drakeley Swimming Pool Company was chosen to build a perimeter edge overflow pool for a contemporary, artistic design firm in the New York countryside. The original plans showed an overflow pool with the idea of water elevation being near or equal to the deck height. Acknowledging the look that the design team was going for, we redesigned the original pool plan by removing a bulky underwater coping stone that visually highlighted the lower water elevation and pool perimeter to a new "Lautner Edge" (refer to Fig. 1). This edge detail is a knife-point gutter system allowing the coping to virtually touch the edge point with a small slot, allowing water to flow into a recessed channel. Having the water near deck level, without seeing an unsightly underwater coping and trough, is the continuation of space that the clients envisioned. Shotcrete was the only solution that allowed us to create this detail. Shotcrete, with its in-place compaction and inherently high strength, needed to be watertight not only for the pool vessel but also for the Lautner overflow design. Having variable thicknesses in a durable vertical edge element with consistent water flows simply would not have been possible with conventional concrete and hand casting.

Excavation

The general contractor informed us that they had blasted to a 9 ft (2.7 m) depth for the pool area over 10 years ago because of ledge rock. Our questions for the general contractor were:

- Did you remove the blasted material?
- Did you backfill the excavation with a quality fill?
- Was the backfill compacted in lifts?

The answers were “No, No, and um, er, ah, No.” The parameters of the pool were 60 x 20 ft (18 x 6 m), with a deep end of 8 ft (2.4 m). Our excavation crews encountered unsuitable materials as we dug through the previously placed fill. It was all shot rock surrounded by clay/silt/fines that would not support a pool structure. We needed to find the bottom of the previously filled material and start from there. After 15 ft (4.6 m) of digging from form height, we finally found hard ledge rock (Fig. 2). A problem with this was that the overblast excavation area undermined an 8 ft (2.4 m) wall running along the pool side, as well as its footing, both of which were built prior to the pool construction. Our crews dug, then placed and compacted stone as we went from deep end to shallow (Fig. 3). This sequence allowed continued support for the freestanding wall as we progressed through the excavation. The compacted stone gave us a stable base on which to support the pool shell without movement or differential settlement. This is critical in any concrete/shotcrete construction, but is especially important when the subgrade is loaded with a high weight like water.

Plumbing

The perimeter slot overflow is an atmospheric condition, meaning gravity flow is through large-diameter piping. When using polyvinyl chloride (PVC) piping, the pipe must be rigidly plumbed and then completely encased with proper shotcrete cover. The pool wall bond beam was to be 3 ft (0.9 m) thick. The backside, after a vertical depth of 2 ft (0.6 m), transitioned into a 12 in. (300 mm) wall, which connected to a 12 in. (300 mm) thick floor. Our plumbing was 4 in. (100 mm) in diameter for each long wall side of overflow collection and then expanded up to a 6 in. (150 mm) trunk line. Our return was a 4 in. (100 mm) pipe around the perimeter. Both lines used tees and bushings down to 2 in. (50 mm) fitting connections (Fig. 4). The bond beam was thick enough to fully encase all the piping. The reinforcing steel, however, would have been less uniform and required more freeform bending to get around certain locations. To avoid these problems, we placed the long wall open-side collection pipe outside of the bond beam with only 2 in. (50 mm) fitting stubs through the wall (Fig. 5). All other piping was either fully encased in the wall by shotcrete or in the stone layer under the pool shell.

Forming and Steel

Because the slot overflow was part of a 3 ft (0.9 m) wide bond beam, we constructed it with


Fig. 2: Bottom of excavation to solid, undisturbed soils/rock


Fig. 3: Drainage stone layer, retaining stone bags, and compaction


Fig. 4: Reinforcing bar installation, retaining stone bags, and piping

a two-stage shotcrete process. Our reinforcing steel configuration used three cages for the bond beam with No. 5 (No. 16M), No. 4 (No. 13M), and Grade 60 (420) deformed bar. Its grid pattern was offset using 12 x 12 in. (300 x 300 mm) spacing. The first shoot left the top of the pool with a 2 ft (0.6 m) haunch detail (meaning the backside was higher than the front.) This raised haunch had each of the 2 in. (50 mm) diameter piping overflow dropouts properly encased with the surrounding steel in shotcrete. Using Grade 60 (420) reinforcing steel requires an automatic/hydraulic bending machine. The lower walls had No. 4 (No. 13M) bars with a double-cage offset. This offset is a 6 in. (150 mm) grid pattern in plan or cross-sectional view. Our forming was with rigid plywood, 2 x 4 in. (50 x 100 mm), and 1 x 6 in. (25 x 150 mm) rough-sawn lumber. This allows very good rigidity to accept the impact of the shotcrete without breaks or voids. The long wall adjacent to the raised decorative stone wall was shot next to its concrete footing. Tolerance of the edge design is critical in all phases of pool construction but especially in our second stage of shooting. To get the knife edge, we were to drill in new steel reinforcing bar with connecting and horizontal bars and form an inverted angle bracing to shape the runoff of the backside of the edge into the hidden trough. This edge angle was to match the cut angle of the future coping stone keeping a parallel 1 in. (25 mm) slot. Our flow of water in gal./minute (L/minute) depends on the levelness of the edge. Because the concrete material was going to be shot to a point, it was important that we over-shoot by approximately 1 in. (25 mm) and then grind down the installed material, forming a more rounded edge. The forming was installed for this technique. This edge is the essential design piece, melding the pool water level with the deck elevation and exemplifying the pool's organic architecture. Our forming and steel installations always had that end goal in mind.

Fig. 5: Beam profile of first stage of shooting process

Shotcrete

Shotcreting took 3 days. Because the walls and floors were thick, we used (including surge tank) a total of 160 yd^3 (122 m^3) of in-place materials. Our concrete specifications required a 4000 psi (27.6 MPa) compressive strength after a 28-day wet cure as a bare minimum. The actual concrete strengths after 7 days were 4820 psi (33.2 MPa) and above, according to independent lab testing by the general contractor (refer to Table 1). Our mixture design was rich portland cement with a maximum water-cement ratio (*w/c*) of 0.45. This mixture provides more than enough paste binder to cover 100% of the aggregate gradation in terms of total surface square feet. Most shotcrete appli-

Table 1: Shotcrete Compression Test Report PT471CL-01B-10-10

Laboratory Data (ASTM C39, C42, C511, and C1231)

Core ID	Date of test	Age, days	Drilled core length, in. (mm)	Uncapped core length, in. (mm)	Capped core length, in. (mm)	Capped core diameter, in. (mm)	Core area, in.^{2} (mm^2)	Total load, lb (kg)	Strength correction factor	Unit load, psi (MPa)	Core location
01	10/12/10	8	3.87 (98.3)	3.12 (79.2)	3.66 (93.0)	2.72 (69)	5.80 (3742)	27,960 (12,682)	1	4820 (33.2)	Test panel 1
02	10/12/10	8	3.92 (99.6)	3.11 (79.0)	3.64 (92.5)	2.71 (69)	5.76 (3716)	29,770 (13,503)	1	5170 (35.6)	
03	11/01/10	28	3.91 (99.3)	3.53 (89.7)	4.01 (101.5)	2.72 (69)	5.80 (3742)	40,640 (18,434)	1	7010 (48.3)	
04	11/01/10	28	3.83 (97.3)	3.44 (87.4)	3.93 (99.8)	2.72 (69)	5.80 (3742)	34,850 (15,808)	1	6010 (41.4)	
05	11/01/10	28	3.83 (97.3)	3.09 (78.5)	3.76 (95.5)	2.72 (69)	5.80 (3742)	40,880 (18,543)	1	7050 (48.6)	

Note: Unit weights are approximate and are calculated based on cylinder weights and volumes determined in the laboratory. *Table courtesy Atlantic Testing Laboratories* cators or designers are unaware of this crucial aspect of the concrete mixture design (refer to Table 2). The shotcrete method of placement uses the wet process (Fig. 6). The wet-mix pump (Allentown PC 20) was coupled with an Ingersoll Rand air compressor with a capacity of 375 ft^3/minute (175 L/s). We used a secondary air compressor (185 ft^3/minute [86 L/s]) primarily to run the air lance. The air volume and velocity is important to properly compact shotcrete materials especially (as in our case) when there is more than one layer of steel reinforcement. Our output was 10 yd^3/h (7.6 m^3/h) with a truck every hour. We reduced the steel pipe from 5 in. (125 mm) at the pump discharge to 3 in. (75 mm) steel pipe at the pool edge. At the pool edge, we reduced with a 3 x 2 in. (75 x 50 mm) reducer into a 2 in. (50 mm) flexible hose connected to our nozzle. Our crews began shooting the entire floor first, and then proceeded with the walls. With wet mix, we had very minor aggregate rejection, which produced no significant rebound. An important aspect of the shooting process was cleaning overspray from the reinforcing steel adjacent to the shotcrete placement. We used air from a nozzle (minus concrete) and an air lance to clean the reinforcing steel. This waste material collected on the previously shot floor, was collected, and then shoveled out. After each application, we prepped all construction joints to a roughened surface at a 45-degree angle and made sure they were in a saturated surface-dry (SSD) condition prior to receiving more material. Even though the shoot was over a period of 3 days, this pool shell, with no expansion joints, is still considered monolithic concrete. Once the pool was completed and reached final set (well over the specified 500 psi [3.4 MPa] minimum), the general contractor slowly started to fill the pool to over 3/4 full with water to: a) satisfy the project specifications that required watertight concrete prior to subsequent surface applications; and b) cure and keep concrete in a moist condition to help minimize any concrete shrinkage (Fig. 7). The concrete ready mix plant was local and used local materials for the sand and aggregate, keeping in step with our organic objective.

Finished Materials

After all plumbing and fitting installations, our last work before startup was applying the finished surface materials. The overflow slot was lined with a slate/stone tile and a gray plaster to seal fitting connections and dropouts. The pool interior was given a typical gray plaster to match its surroundings. Because the pool shell was required to be watertight and compressive values were indicative of good shotcrete, we needed no additional waterproofing (technically "dampproofing"). The general contractor applied a New

Table 2: Batch Weights Per Cubic Yard

Cement (ASTM C150 Type I/II)	800 lb (363 kg)
Sand (ASTM C33) SSD	2325 lb (1055 kg)
ASTM No. 8 stone (3/8 in. [9.5 mm])	300 lb (136 kg)
Water	43 gal. (163 L)
Air Mix 200	1.0 ± 0.5 oz/cwt (0.62 ± 0.31 g/kg)
WR 91	2.0 oz/cwt (1.25 g/kg)
Air content	8 to 10%
Slump	3 in. (76 mm)

Admixtures: all The Euclid Chemical Company, Cleveland, OH
Air entraining agent: Air Mix 200; water reducer: WR-91

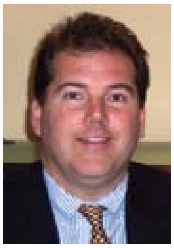
Fig. 6: Wet-mix shotcrete process, ACI Nozzleman shooting base of walls

Fig. 7: Lautner edge in place, tank testing for water tightness

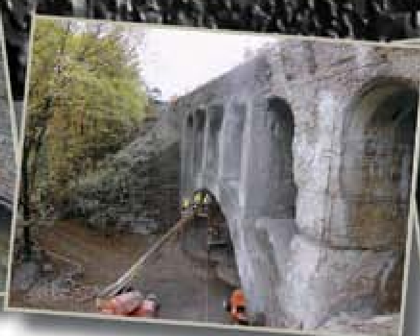
England marble stone for the pool coping and cover of the trough. The design details (refer to the cross section) require a 1 in. (25 mm) gap between all edges. One-hundred-percent of the perimeter is near deck level and 100% of water (during secondary edge flow pump mode) flows over the edge in a skimming capacity. Specialty water edges such as that produced on this project require durability, water tightness, and precise installation techniques to be successful. Hand-packing or casting materials without the high-velocity impact inherent in shotcrete just won't give you the performance that these water edges demand. Tight finished tolerances allow this project to enjoy significant energy savings by use of a variable speed, energy-saving pump for the edge flow. The pool sanitation is primarily organic through ozone generation, and the heating system uses a high-efficiency heater unit. The finished product (Fig. 8) is a seamless, durable shotcrete structure (perhaps better considered a shotcrete artwork) that perfectly embodies the architectural philosophy.

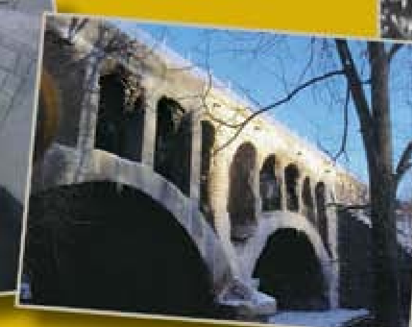
To make this contemporary concept a reality, we relied on the many benefits inherent in shotcrete. Over-blasted conditions, strength, water tightness requirements, and gutter detailing to a point all required our knowledge and experience in sophisticated, high-tech concrete placement with shotcrete. As a builder, it's intuitive to try and simplify designs. This thought process makes the job easier for the field construction team and yields faster completion dates with less hassle. However, as a firm believer in always raising the bar (strength, applications, and so on), I believe we as pool shotcrete builders have a responsibility to see the project through the eyes of the architect or designer. Imagine the "wow" factor of a client if we were to bring different architectural designs into our pool construction presentations. As an industry, we must climb the credibility ladder. Being in tune with an established and accepted form of architecture (such as Wright and Lautner) brings all of us to a level of opportunity in all things shotcrete that we would have never reached before. Couple this with future credibility from the American Concrete Institute or ASA, and I seriously doubt any of us would ever run out of work.

Fig. 8: Finished pool



__Bill Drakeley__ is President of Drakeley Industries and W. Drakeley Swimming Pool Company. Drakeley Industries is a shotcrete consulting firm that is dedicated to the training and implementation of the shotcrete process in regards to building water-retaining structures, ground support, and underground shotcrete application. Drakeley Pool Company is a design/build construction and service firm specializing in in-ground, high-end commercial and residential pools. Drakeley is an active member of ACI Committee 506, Shotcreting. He is the first ACI Certified Shotcrete Examiner from the pool industry nationwide. Drakeley is also an ACI Certified Nozzleman, ASA Board of Direction member, ASA Technical Advisor, and Chair of the ASA Pool & Recreational Shotcrete Committee. His writings have been published in national and international trade magazines, including Shotcrete*,* Watershapes*,* Pool and Spa*, and* Luxury Pools *magazines. In addition, Drakeley is a Platinum Member of the Genesis 3 Group, a licensed member of the Society of Water Shape Designers, and a member of the Association of Pool and Spa Professionals (APSP). He is also the concrete/shotcrete instructor at the Genesis 3 Pool Construction Schools and NESPA Region 1 Show in Atlantic City. As an instructor/trainer, Drakeley has given lectures on shotcrete applications for various pool trade shows and for World of Concrete. Drakeley is an Expert Witness regarding shotcrete applications for the swimming pool industry.*





Brown University

By Mason Guarino and Robert Guarino

Brown University, a prominent Ivy League university located in Providence, RI, decided to add a new aquatics center with an Olympic-qualifying 164 ft (50 m) pool. Shawmut Design and Construction was awarded the general contracting contract and South Shore Gunite Pools & Spas, Inc., was awarded the swimming pool contract. World-renowned swimming pool consultant Counsilman ■ Hunsaker was the swimming pool designer of record.

Fig. 1: Installed one of the two bulkheads that go in the pool

This competition swimming pool was required to be built to NCAA and Olympic standards and was to be certified by the governing bodies for its competitive aspects. Certification means that the critical lengths of the swimming lanes fall within very tight tolerances—down to 1/16 (0.0625) of 1 in. (1.6 mm)—as required by the swimming sport organizations. The overall final dimensions of the pool were 183 ft (55.8 m) long x 75.1 ft (22.9 m) wide, ranging from 4 to 12.5 ft (1.22 to 3.84 m) deep and holding just less than 1,000,000 gal. (3,800,000 L) of water. The water is filtered at a staggering 3000 gal./minute (11,356.2 L/minute) through two state-of-the-art regenerative media filters powered by two 40 horsepower (30,000 watt) pumps.

The reason for the increase in size was to accommodate two movable bulkheads (Fig. 1). The movable bulkheads are 4 and 6 ft (1.22 and 1.82 m) fiberglass platforms that can move to change the desired length of the pool. On a positive note, after construction was complete, the pool was successfully fully certified.

The intended design of this pool was cast-in-place concrete. We were successful in converting the cast walls to shotcrete. This saved time and money on an already-taxing budget and schedule because we all know whether it is cast, shot with dry-mix, or shot with wet-mix, at the end of the

Fig. 2: Pool floor after the floor was cast but before shotcrete placement

Fig. 3: Completed cast floor and shotcrete walls

day, 4000 psi (28 MPa) concrete is still 4000 psi (28 MPa) concrete.

In reviewing methods of construction of the pool due to the sheer size of the pool and the fact that it was designed to adhere to the ACI 350 Code for liquid-containing concrete structures, it required approximately 900 yd^3 (690 m^3) of concrete and 52 tons (47 metric tons) of reinforcing bar. The final decision on the construction method was to cast the floor and shotcrete the walls (Fig. 2 and 3). This combined the best of both techniques. Casting the floor is far more cost-effective than shooting the floor. Then, using either wet- or dry-mix shotcrete and single-sided formwork was a real money-saver.

In addition to the use of single-sided forms, we had several other money- and time-savings aspects. We decided to thin-set the tile interior rather than use a 0.75 in. (19 mm) mud base. We also had a very elaborate surface-skimming system that, if cast, would have required extensive formwork, cold joints, and a lot of waterstops. Using shotcrete, we needed only one waterstop between the walls and the floor. The 400 yd^3 (305 m^3) floor casting took 15 men about 10 hours to place and finish. We then wet-cured the floor for 7 days before starting to shoot the walls (Fig. 4). Another great thing about casting the floor is that it allowed us to erect our OSHA-compliant staging on the floor, making movement much easier.

The walls provided some challenges. We had planned on taking about 8 days to shoot the walls because when we build large pools, we usually use two shotcreting crews. Due to site constraints, we could only use one crew and had to shoot from 250 to 350 ft (76 to 106 m) away from the actual placement location. This cut our production down to about 50 yd^3 (38 m^3) per day.

The equipment used was an Ingersoll Rand 825 compressor, an Airplaco model C-10 gun, a Cemen Tech batching plant (trailer-mounted), a John Deere 555 loader (to load sand), and a Right Way portable silo. We used the Cemen Tech batching plant that mixes materials for both wet- and dry-mix shotcrete on larger commercial jobs because, in our experience, using an Airplaco mobile mixer would have been a more difficult setup. Because the Cemen Tech unit is self-contained, small, and portable, we can set it up and shoot all day without stopping. This saves a lot of money because you use less fuel and it allows you to shoot 12 to 15 yd^3 (9.2 to 11.5 m^3) more per day by not having to back concrete trucks in and out. The Cemen Tech is more affordable for these types of jobs because you don't need a \$100,000 concrete truck idling on site while you shoot. We find that one man can run the Cemen Tech unit, load sand and cement,

Fig. 4: Shotcrete in progress. This pool required significant formwork, as 85% of the pool was 9 ft (3 m) deep or deeper

Fig. 5: The shotcrete mixture was made on site using a portable cement silo and a volumetric batch plant. This saved on material costs, allowed us to control our mixture and material delivery, and eliminated concerns regarding possible breakdowns with a concrete truck. Also shown is the truck-mounted 825 CFM air compressor

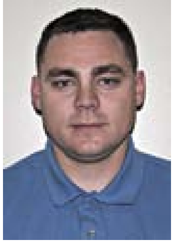
and keep the gun running properly all day long (Fig. 5).

Our crew consisted of two ACI Certified Nozzlemen—one shooting and one operating the blowpipe—three finishers, one skid steer operator, and three laborers. Our silent crew member was Chris Zynda, whom we met through ASA (yes, membership does have its privileges). Chris helped us determine the best method to marry the poured floor to the shot walls. The decision was made to depress the exterior of the pool perimeter 3 in. (76 mm) deep within 6 ft (1.8 m) of the

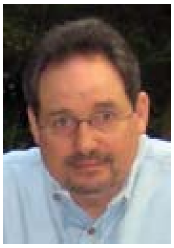
Fig. 6: Pool completed and in use for a water polo competition. South Shore Gunite also installed the 11 x 24 ft (3.4 x 7.3 m) video screen

exterior edge. This allowed for an area for the shotcrete to be finished into so that it did not need to be finished to a feathered edge. No bonding agent was used when shooting onto the previously cast concrete. However, we did power-wash the surface very thoroughly to remove any laitance and made sure the surface was saturated surface-dry prior to the application of the shotcrete. The concrete floor surface where shotcrete would be placed was left very rough in the finishing process to help increase the bond. A waterstop was also used in the floor/wall joint as inexpensive backup to properly bonded shotcrete.

The Brown University pool was opened as scheduled with the pool events starting immediately (Fig. 6). One of the toughest parts about the commercial pool industry is keeping the general contractor on schedule throughout the entirety of the job. The pool contractor is often on site from the beginning of the project to the end. This allows the general contractor to easily push off pool items that are not as important at the beginning of the project. If we allowed that to happen, we would end up being the ones scrambling at the end of the project to get our work done on time. Often, with paying customers, swimming pool activity schedules are created months before the pool is actually complete. If the pool is not done on schedule, the facility could potentially lose thousands of dollars per week and may trigger substantial liquidated damage charges to the contractor. Through planning and project management, projects can be finished on time and even weeks early.

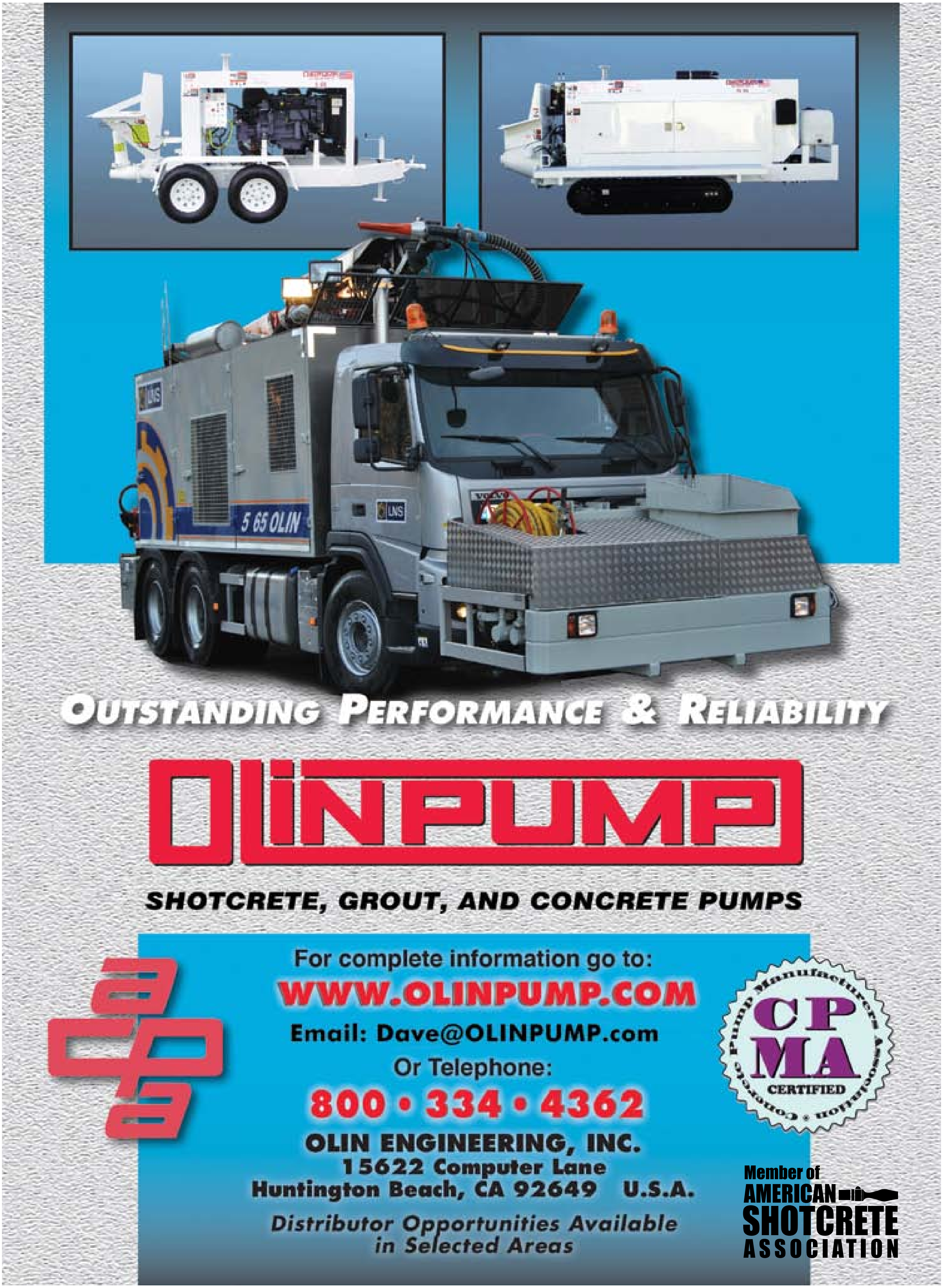


Mason Guarino *started in the pool industry when he was 14, learning how to install reinforcing bar. Since then, he has worked on all phases of the swimming pool industry. Guarino has been with South Shore Gunite Pools & Spas, Inc., full-time since graduating from the Wentworth Institute of Technology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



Robert Guarino *has been in the pool industry for over 30 years, more than 20 of which he has served as the President/Owner of South Shore Gunite Pool & Spa, Inc., with strongholds in both the residential and commercial sectors. He is an ACI Certified Nozzleman and a member of the National Plasterers Council, the Better Business Bureau, and ASA.*

Author's note: *This article is dedicated to longtime employee—and even longer-time shotcreter—Tony Zeleneski. Tony and I were the first ACI Certified Nozzlemen in Streetsboro, OH. —Robert Guarino*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The Right Choice

By Jamie Scott

For those in the watershape, skate park, and other recreational industries, shotcrete's advantages over the form-and-pour method are numerous and well documented. In my view as a project manager, however, one set of advantages does not get the credit it should. The shotcrete process—by default—incorporates the conveyance of concrete to the point of use, placement of the concrete, and the finishing work. This combined process is of great benefit for those who have the responsibility of assembling a team to build a project.


Foundation exposed down to footing drains


Bluestone deck and rear garden

For me, this became an eye-opening realization as I was considering how I would handle the concrete work on several renovation projects. One of the decisions to be made was whether to use shotcrete or poured-in-place concrete. It didn't take long before I realized that I would have to hire and coordinate multiple trades if I were to use the poured concrete option. Rather than just relying on my dry-method shotcreter, I would need to bring together a ready mix company plus a pump truck plus concrete placers and finishers. The decision became obvious.

Renovation projects, in particular, benefit greatly from shotcrete, as truck access to the project area is usually limited or nonexistent. There's no need to hire a separate pump truck when shotcreting—it's all part of the process. The two projects listed in the following will help amplify this point.

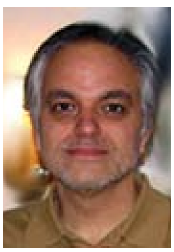
One renovation project entailed exposing a foundation of an old residential estate in Scarsdale, NY. The inside of the house had recently been renovated. However, water was now coming into the rear basement rooms when it rained, which had to be addressed. It was fairly evident that we had to get to the foundation and footing drains.

This area of the house was completely cut off from the driveway or any other access. So, a great deal of hand labor was going to be called for—starting with the excavation work. After the footing drains were repaired and the foundation was waterproofed, everyone had had enough of hand work! It was now time to reinstall a very large Bluestone deck over the space, which called for a subgrade reinforced concrete slab. To avoid having to hand-carry the concrete materials up a long stone staircase to the project area, we brought in the shotcrete contractor. Not only did it save labor, it also took a quarter of the time it would have taken otherwise—a great use of the shotcrete process.

Another renovation project was a swimming pool in Darien, CT. The pool had been built many years ago and although it was structurally sound, it was missing some desired amenities. The homeowner decided to add a large underwater bench, over which they could cantilever a boulder and pipe water to create the sight and sound of water falling.

We notched back into the pool shell a bit, so as to give the concrete an edge to stop against. Then, reinforcing steel was epoxied into place, taking care to have the electrician attach the bonding wire for safety. Again, access was nonexistent due to it being a developed, mature property. So, shotcrete was used to install the concrete to create the bench and produce a concrete footing for the boulder to sit on.

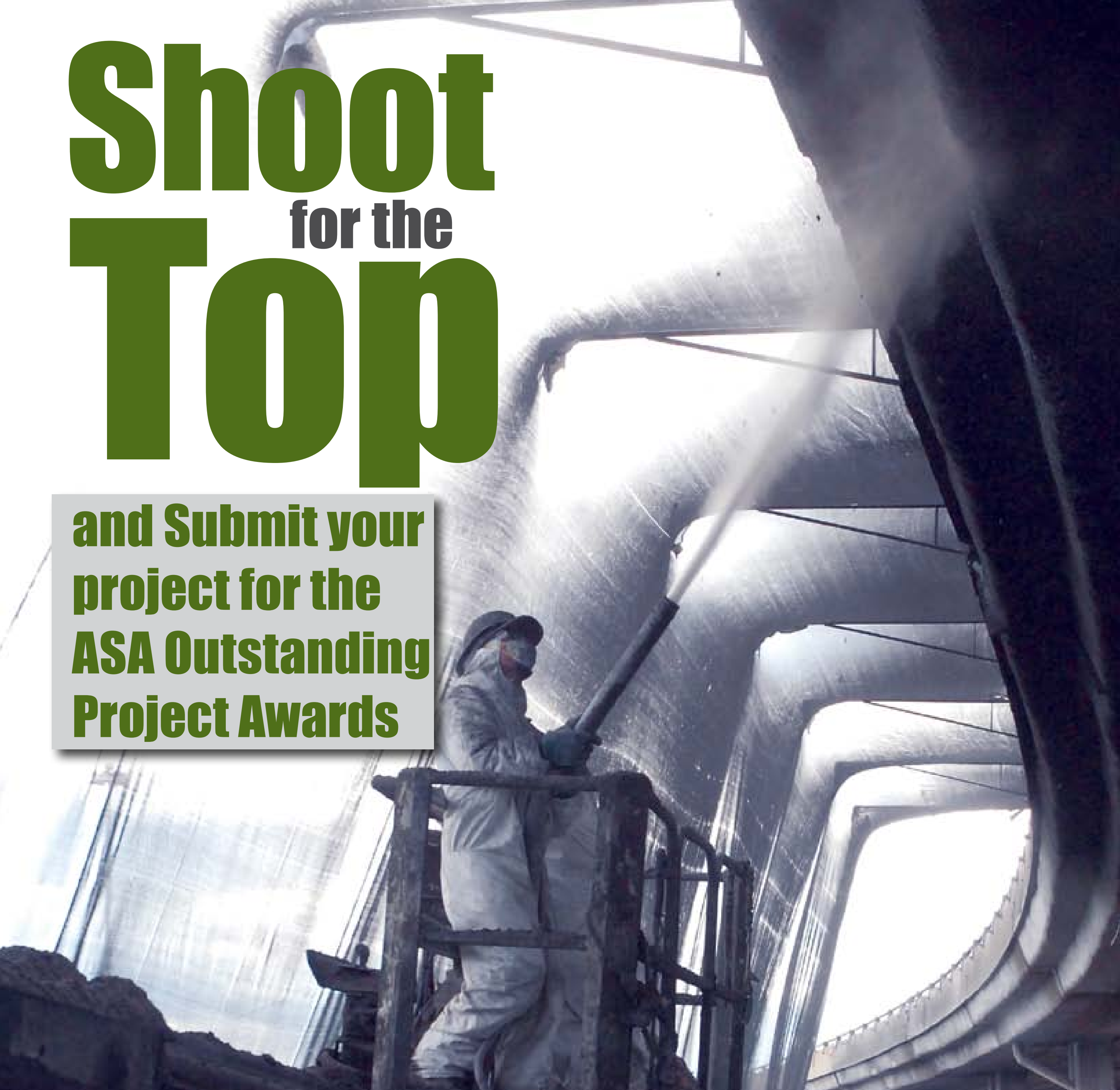
Shotcrete has proven to be the right process when access is limited and ease of application is desired.



Jamie Scott *is a third-generation Watershape Designer and Builder who has worked in the swimming pool and landscape industries for 39 years. He received his BS in business and accounting from Southern Methodist University, Dallas, TX. Scott co-owned a high-end pool and landscape firm until 1998, when he divested to found a new firm, Group Works LLC, based in Wilton, CT. Through Group Works LLC, Scott has aligned himself with Genesis 3 and other organizations that focus on continuing education and increasingly higher standards in the watershape industry. He is a Platinum Member of Genesis 3 and a certified member of the Society of Watershape Designers. Scott is also an APSP-Certified Professional Builder and an ASA member and has trained with the Portland Cement Association. Additionally, he is on track to become a licensed landscape architect. Scott and Group Works LLC have been featured in regional and national publications.*

Pool shell ready for shotcrete

New bench and boulder



Pool & Recreational Shotcrete Corner

On behalf of the Pool & Recreational Shotcrete Committee, I am proud to announce the establishment of our second position statement, "Definitions of Key Shotcrete Terminology." Getting back to basics in the shotcrete arena starts with understanding all of its components. This position statement identifies key terminology in the spray process and provides their formal definitions. As a pool contractor, having an understanding of and being able to identify the components of the process is half the battle in successful application.

As stated in Position Statement #1, "Compressive (Strength) Values of Pool Shotcrete," this information is to be used continually as a builder's reference. These statements are voted on and approved by ASA for the betterment of pool builders specifically, although these guidelines are relevant to other industries that use shotcrete applications. ASA is currently working on three new position statements highlighting water tightness, sustainability, and mixture designs. Our goal as the ASA Pool & Recreational Shotcrete Committee is to help pool builders who work with shotcrete identify proper applications and methodology. This can also be found on the ASA Web site at **www.shotcrete.org/poolpositionpaper_2**. Add this position statement to your library!

William T. Drakeley
Chair, Pool & Recreational Shotcrete Committee

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American Shotcrete Association's Pool & Recreational Shotcrete Committee Position Statement #2

Definitions of Key Shotcrete Terminology

Shotcrete specifications—from mixture design through application—hold pool contractors responsible for shotcrete performance. Engineering plans, architectural renderings, or referenced concrete standards applied to pool construction use a variety of shotcrete terminology—both correctly and incorrectly. Understanding the meaning of the terminology is paramount to understanding the entire process as it relates to the pool construction industry. These key shotcrete terminology definitions are a starting point for any contractor building concrete swimming pools using the shotcrete process.

Shotcrete as a technology is not industry-specific. ASA and its Pool & Recreational Shotcrete Committee, however, are currently narrowing the focus on some key phrases or definitions that are used consistently in their practice area. These are steps to increase the cohesiveness and the uniformity of the shotcrete industry. Having contractors understand and use the same terminology for both the dry- and wet-mix processes immediately improves communication and understanding of all involved in the shooting applications. This understanding is the first step toward the universal acceptance of the shotcrete process by the entire pool industry.

TERMS	DEFINITIONS
Shotcrete	A concrete-placing process where concrete mixtures are conveyed through a hose and then pneumatically projected at a high velocity onto a surface to achieve high-quality, in-place compaction. It produces high-quality dense concrete with a low water-cementitious material ratio (*w/cm*), low permeability, and a high cementitious material content.
ACI	The American Concrete Institute (ACI) develops and publishes consensus documents (codes, specifications, and guides) for the shotcrete process through ACI Committee 506, Shotcreting. ACI also maintains the ACI Shotcrete Nozzleman Certification program under the guidance of ACI Committee C660.
ASA	ASA is a nonprofit organization of contractors, suppliers, manufacturers, designers, and engineers that encourages and promotes the safe and beneficial use of the shotcrete process. ASA is the primary sponsoring group for administering the ACI Shotcrete Nozzleman Certification program.
Admixture	Any material deliberately added to concrete before or during mixing, other than cementitious material, water, aggregates, and fiber reinforcement.*
Blowpipe	Air jet operated by a nozzleman's helper in shotcrete shooting to assist in keeping rebound or other loose material out of the work. Also known as an air lance.†
Brooming	A finishing procedure in which a broom is pulled across the shotcrete surface to roughen the surface.†
Cementitious paste	Mixture of cementitious material and water that is part of concrete.*
Compressive strength	Measured maximum resistance of a concrete or mortar specimen to axial compressive loading, expressed as a force per unit cross-sectional area (for example, lb/in.^{2}).*
Concrete	A mixture of two components: aggregate and paste. The paste is made of cementitious materials and water and acts as the glue that binds the aggregates (sand and/or ground or crushed stone) into a hardened mass due to the chemical reaction of the cement and water (hydration).*†
Consistency	The relative mobility or ability of freshly mixed concrete or mortar to flow.*
Cracking	It occurs when the rate of evaporation exceeds the rate of bleeding.*

Pool & Recreational Shotcrete Corner

Curing — Action taken to maintain moisture and temperature conditions in a freshly placed mixture to allow cementitious material hydration to occur so that the potential properties of the mixture may develop.

Cuttings — Shotcrete material that has been applied beyond the finish face and is cut off in the trimming or rodding process.[†]

Delivery equipment — Equipment that introduces and conveys shotcrete material into the delivery hose.

Delivery hose — Hose through which shotcrete materials pass on their way to the nozzle; also known as the material hose or conveying hose.[†]

Dry-mix shotcrete — Shotcrete in which most of the mixing water is added at the nozzle.[†]

Earth surface — When used as forms, must be firm, stable, and trimmed to the desired lines of the finished concrete.

Entrained air — Microscopic air bubbles intentionally incorporated in mortar or concrete during mixing, usually by use of a surface-active agent; typically between 0.0004 in. (10 μm) and 0.04 in. (1 mm) in diameter and spherical, or nearly so.[†]

Finish — The texture of a surface after consolidating and finishing operations have been performed.[‡]

Finisher — Craftsman who trims and finishes the surface of the shotcrete (also refer to Rodman).[†]

Fly ash — The finely divided pozzolanic residue resulting from the combustion of ground or powdered coal, which is transported from the firebox through the boiler by flue gases.[*]

Forms — A system for the in-place support of fresh shotcrete, which is rigid enough to resist the impact force of shotcrete while maintaining the intended shape and preventing excessive vibration.

Ground wire — Small-gauge, high-strength steel wire used to establish line and grade for shotcrete work; also called alignment wire, screed wire, or shooting wire.[†]

Gun — Dry-mix shotcrete delivery equipment.[†]

Gun finish — Undisturbed final layer of shotcrete as applied from a nozzle without hand finishing. Sometimes referred to as a natural finish.[†]

Gun operator — Craftsman on dry-mix shotcreting crew who operates delivery equipment. Sometimes referred to as "gunman."[†]

Gunite — Trade name originally used for dry-mix shotcrete.[†]

Hose tender — Crew member responsible for moving and/or adjusting delivery hose to aid nozzleman; also responsible for delivery hose connections.

Hydration — The chemical reaction between hydraulic cementitious material and water.[*]

Impact velocity — The velocity of the material particles at impact on the receiving surface.[†] (Ideal at 350 to 400 ft/s [106 to 122 m/s].)

Mortar — A mixture of cementitous paste, fine aggregate, water, and admixtures. In fresh concrete, this is the material that occupies the spaces between the particles of coarse aggregate.[*]

Nozzle — Attachment at end of delivery hose where shotcrete is projected at high velocity.[†]

Nozzleman — Craftsman on a shotcrete crew who manipulates the shotcrete nozzle, controls material consistency (dry process), and controls the final placement of the material.

Overspray — Shotcrete material deposited away from intended receiving surface.[†]

Plastic shrinkage — Cracking that occurs in the surface of fresh concrete soon after it is placed and before initial set.

Pneumatic feed — Shotcrete delivery equipment in which a pressurized air stream conveys material.[†]

Positive displacement	Wet-mix shotcrete delivery equipment in which a pump or other non-pneumatic means pumps the material through the delivery hose in a solid mass.†
Porosity	The ratio of the volume of voids in a material to the total volume of the material.
Permeability	The rate of flow of water through a cross-sectional area of a porous medium under a given hydraulic gradient and temperature condition.
Pozzolan	A siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.*
Predampening	In the dry-mix process, adding water to the aggregate before mixing to bring its moisture content to a specified amount, usually 3 to 6%.†
Pump	Wet-mix delivery equipment.†
Pump operator	Craftsman on wet-mix shotcreting crew who operates the shotcrete pump.†
Rebound	Shotcrete material that bounces away from the surface against which the shotcrete is being projected.† Rebound has inadequate cementitious content as compared to the original shotcrete.
Rod	Sharp-edged cutting screed used to trim shotcrete to forms or ground wires.†
Rodman	Craftsman on the shotcrete crew who uses a rod or other tools to trim and finish the shotcrete.†
Rolling	The result of applying shotcrete at angles less than 90 degrees to the receiving surface, resulting in an uneven, wavy, textured surface at the outer edge of the spray pattern.†
Saturated surface-dry	(SSD) The moisture condition of the substrate so that it does not absorb water from the placed shotcrete.
Sand pocket	A zone in the shotcrete containing fine aggregate with little to no cement† (sand lens).
Shadow	The area behind an obstacle that is not adequately impacted and compacted by the shotcrete stream. In hardened shotcrete, shadow refers to any porous area behind an obstacle, such as reinforcement.†
Sloughing	Subsidence or sliding of shotcrete, generally due to excessive water in the mixture, also called sagging.†
Slump	A measure of the consistency of fresh concrete equal to the subsidence of a molded specimen immediately after removal of the slump cone.*
Substrate	Any material surface onto which shotcrete is applied.
Waterproof	Completely impervious to water in either liquid or vapor state. (Because nothing can be completely "impervious" to water under infinite pressure over infinite time, this term should not be used.‡)
Watertight	Impermeable to water except when under hydrostatic pressure sufficient to produce structural failure.
w/cm	The ratio of the total amount of water (including water in high-range water-reducing admixtures [HRWRA]) to the amount of cementitious material (portland cement, fly ash, silica fume, slag, or other supplemental cementitious materials) in a concrete mixture, stated on the basis of weight or mass; frequently abbreviated *w/cm*.*
Wet-mix shotcrete	Shotcrete where the concrete, including water, is completely mixed prior to introduction into the delivery hose; compressed air is introduced to the material flow at the nozzle.

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*ACI Certification Craftsman Workbook (CP-60 09), American Concrete Institute, Farmington Hills, MI, 2009.

†ACI Committee 506, "Guide to Shotcrete (ACI 506R-05)," American Concrete Institute, Farmington Hills, MI, 2005, 40 pp.

‡"ACI Terminology," American Concrete Institute, Farmington Hills, MI, 2010, http://www.concrete.org/Technical/CCT/ACI_Concrete_Terminology.pdf. (last accessed May 23, 2012)

Technical Tip

Swimming Pool Scaffolding

By Mason Guarino

In the shotcrete swimming pool installation process, proper work platforms have always been a necessity during the shotcreting process. Not only are work platforms for working comfort but they are also necessary to give nozzlemen ready access to the correct angles for shooting the material into place. Without proper work platforms, the nozzlemen would have difficulty controlling rebound and properly encapsulating the reinforcing bars. In addition to the nozzlemens' access requirements, the finishers need to be able to reach the shotcrete surfaces to provide the final shotcrete finish. Unfortunately, the work platforms for nozzlemen and finishers are typically different. The nozzlemen need to be a few feet away from the work and typically a little bit above it, whereas a finisher needs to be much closer. The always-changing work surface and different access requirements for the various shotcrete team members constantly present a challenge regarding how to accomplish the work in a safe manner while still being able to work efficiently.

In the course of a single day, the crew may need at least four different working positions. In the same placement area, the nozzlemen and the finishers need two different working locations and it is not uncommon to install multiple courses of material in one day. Due to the different distances from the working surface required, it is impossible to simply install all the scaffolding beforehand, as would be typical for a masonry crew installing a concrete block wall. Basically, if all the scaffolding is erected beforehand, much of the scaffold would get in the way, preventing proper nozzle technique. This creates the need for a scaffolding setup that can be moved, or disassembled and assembled quickly and easily. Powered boom lifts are out of the question because they would have to be set inside the pool. If the pool floor is shotcrete, there would not be enough time for the shotcrete to gain enough strength to carry the weight to use them. There are many options of staging available; however, due to safety guidelines, the options have become more limited than they were in the past.

In the past, this scaffolding has been taken care of quickly and easily with the use of shotcrete jacks, which are scaffold pieces made of steel that hold three 2 x 4 in. (50.8 x 101.6 mm) pieces of lumber to create the legs and supports. Two legs go to the ground while the plank support is then fastened to the reinforcing bar. This type of staging was fast and convenient but is, in light of today's safety standards, very questionable. OSHA requirements and corporate safety programs have made most commercial general contractors very strict on scaffolding they allow on their job sites. Specifically, scaffolding now must clearly state the structural weight limits. This eliminates the option of jacks holding 2 x 4 in. (50.8 x 101.6 mm) pieces of lumber to be used as scaffolding. South Shore Gunite Pools & Spas, Inc., had been using the jacks without issue of an injury or being questioned up until the mid-2000s. When the questioning of the jacks first began, we were able to convince cautious general contractors to let us use them by adding extra jacks, multiple planks, and fabricating guard rails out of additional 2 x 4 in. (50.8 x 101.6 mm) pieces of lumber. We even used them as high as 8 ft (2.4 m) when working on 12 ft (3.7 m) deep pools. This practice came to an end in 2008, when South Shore Gunite was awarded a Navy Training Pool project with a 12 ft (3.7 m) deep end.

When first awarded this job, we were told that the Navy enforced a very strict safety policy, which would require us to re-evaluate our scaffolding. The U.S. Navy follows safety guidelines created by the U.S. Army Corps of Engineers (USACE). These guidelines are stricter than OSHA requirements. For example, OSHA's requirements for fall protection on scaffolding say that anything over 10 ft (3 m) in height requires fall protection with a guard rail, a mid rail, and a toe board; the USACE guidelines require the same guard rails, but starting at a height of 6 ft (1.8 m). Additionally, OSHA has a rule that says when a work platform for scaffolding is substantially complete enough for someone to stand on, the workers may stand on the platform to complete the installation of final planks and any necessary guardrails. According to the USACE, if possible, all work must be done from stepladders. When working for the Navy, you will find they have construction personnel

Shown here is a scaffolding setup in a pool larger than the Navy pool using a larger movable setup. (Due to Navy rules, we are unable to use actual site pictures) whose specific job is to ensure quality and safety of the construction at all times. After learning about the USACE requirements, it became clear that we needed to acquire the correct scaffolding for this project.

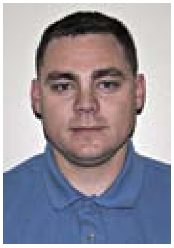
The next step was to decide what type of scaffolding would work best for our shotcrete placement. The main goal was to create a setup that could be moved around quickly and easily. Our decision was fairly conventional with a few tweaks. We went with the typical 7 ft (2 m) long and 5 ft (1.5 m) wide staging sections in 6 and 3 ft (1.8 and 0.9 m) heights similar to what a masonry crew would use on a building. We opted to use 7 ft (2.1 m) long aluminum and plywood plank pieces, however, rather than the 16 ft (4.9 m) long, 2 x 12 in. (50.8 x 304.8 mm) pieces of OSHA-approved plank. The aluminum and plywood plank sections still met the requirements of OSHA and the Navy; however, for ease of assembly, movement, and disassembly, these planks were much lighter and easier to handle. We also opted to use wheels to make the sections easily movable.

The final obstacle was the cove of the pool—in our case, a 2 ft (0.6 m) radius between the wall and the floor; this would not affect the nozzlemens' scaffold platform because 2 ft (0.6 m) is a nice distance to stand and shoot on a wall, but it created an issue for the finishers, as they needed to be against the wall. The problem was solved for the finishers by the use of scaffold side brackets that made the work platform 2 ft (0.6 m) wider so the finishers could reach the final surface properly.

Once the scaffolding was in place, we needed to establish a system to keep the shotcrete crew moving efficiently. We did not want the scaffolding to slow them down. The nozzleman would have one platform for himself and the blow pipe operator, the finishers would have a second platform, and there would be a third platform ready for the next course of shotcrete when the nozzlemen needed to move higher. Using the third platform made it easy for the nozzlemen to immediately move to the next course so the shotcreting placement could continue with minimum interruption. Once the nozzling started on the next course, a laborer would begin rebuilding the first platform for its next use. This helped to eliminate down time between changing working elevations. All of these setups were on wheels and two sections long, making the work platforms a total length of about 14 ft (4.3 m). This size was small enough so that it could be moved fairly easily by the laborers working on the floor but big enough so that it did not have to be moved constantly. This size of a setup was very stable up to our highest work platform elevation of 9 ft (2.7 m).

The movable scaffolding worked very well for the parts of the pool that were deep and relatively flat; however, we did need to build scaffolding without wheels where the pool had steep slopes between different elevations. For access to the scaffolding, we used job-built ladders for the lower platforms that were only about 3 to 4 ft (0.9 to 1.2 m) off the ground and used extension ladders for the platforms 6 ft (1.8 m) and above.

The entire Navy job went very well with no major issues. It was completed on time and even the shotcrete crew, who in the beginning did not like the "new way" of building and using the scaffolding, eventually came around. One of the biggest hurdles was getting the crew to change the way they typically like to move when shooting. They like to start at one spot and continue linearly and without interruption through the job. Due to the somewhat time-consuming processes of building staging and breaking it down, especially where there were steep slopes, they had to move around the pool to the areas that were ready for them to shoot. The jumping around frustrated them, but it did keep the shooting production fairly high. Since the Navy job, we have successfully used the same scaffolding approach on many other commercial swimming pool projects.



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 Wentworth Institute of Technology, receiving his BS in construction management in 2009. Guarino is an active member of ASA and an ACI Certified Nozzleman.*

Shotcrete Nozzleman Basics—Vertical Wall Construction

Why Specific Techniques at the Footing to Wall Joint Are Essential to Product Quality

By Oscar Duckworth

Shortly after the wall was built, it began to leak. Although the owner was unhappy, the crew thought that it was not much of a problem. Coring of the work revealed more trouble than anyone could have imagined.

Placing shotcrete at the construction joint of a concrete footing is a typical procedure. To a nozzleman, this step may appear simple. Begin at the bottom—no big deal. As basic as this may appear, there is much more to the initial shotcrete placement step than you may think. A closer look at the first moments of shotcrete placement will reveal that there are critical—and often overlooked—placement techniques that must be used by the nozzleman and crew to avoid creating hidden structural defects. Specific placement techniques are required to generate satisfactory in-place material at the footing to wall joint. To be effective, the nozzleman must be knowledgeable in these techniques. The long-term performance and durability of the wall depends on it.

Why the Bottom Matters

To understand the critical nature of shotcrete applied along the footing to wall joint, it is important that the nozzleman know more about what is required of the shotcrete material. Concrete and shotcrete are essentially the same material, differentiated by their placement methods. Engineers know that concrete displays behavioral properties that are unique to the product. Concrete can be designed to possess very high compressive strength, but concrete does not perform well in tension. In simple terms, concrete is difficult to crush but can be pulled apart quite easily.

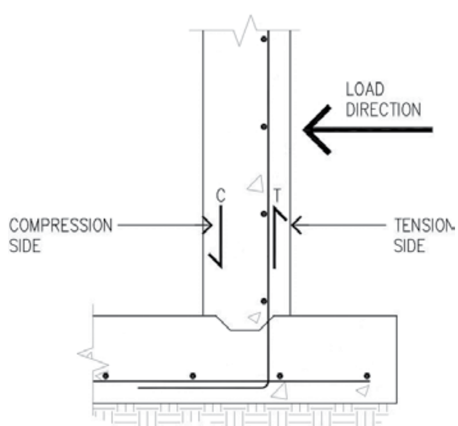


Fig. 1: Concrete compressive strength, f'_c=4000 psi (27.6 MPa). Tensile strength, 8 to 13% of f'_c

Engineers must design around concrete's unique physical properties. Most structural concrete elements are designed to use the reinforcing steel embedded within the concrete to carry the required design loads of the structure. These standard design criteria require the concrete for two main purposes. The concrete must permanently retain the reinforcement at a specific position within the element and must provide the reinforcement with long-term corrosion protection. Traditional wall designs incorporate embedded reinforcement locations that place the concrete at the bottom of a wall within its naturally occurring strong direction (refer to Fig. 1). Loads applied to this wall configuration will force the concrete on the face side of the wall into compression and the reinforcement steel into tension. Concrete works well under compressive loads and steel performs well in tension. For this design to function, the wall's lower areas cannot contain low-compressive-strength concrete or loose materials that can transmit moisture to the reinforcement. Pneumatically applied shotcrete wall designs mirror these standard design parameters because shotcrete is essentially concrete placed through a nozzle.

Why Is Shotcrete Different?

Although the plastic and hardened properties of concrete and shotcrete are similar, the placement procedures of each discipline can strongly affect those mixtures' long-term performance characteristics. This is especially true at the footing to wall joint. By comparison, standard concrete placement operations use mechanical vibration or the use of self-consolidating mixtures to place and encase reinforcement at the bottom of a formed wall. Dense, high-quality concrete must be in place here. The design parameters of the job depend on it.

Shotcrete placement methods use nozzle velocity and impact energy at the receiving surface to achieve required encasement and consolidation of the material. During initial shotcrete placement, impact energy from the high-velocity nozzle stream unintentionally separates some of the mixture's large aggregates as they strike, then rebound off the receiving surfaces along the construction joint. Rebounded aggregates are generated by nozzle velocity; therefore, rebound cannot be prevented. These rebounded aggregates tend to accumulate in the joint during placement (refer to Fig. 2).

Loose aggregates lack sufficient paste to develop required strength and do not provide necessary moisture resistance to protect the reinforcement. Loose rebound cannot be tolerated within this critical area of the wall. By far the most preventable cause of moisture-related defects or reduced service life of a structure is accumulated rebound lenses and loose, unconsolidated rebound pockets within the in-place work (refer to Fig. 3).

If It Is Predictable, It Is Preventable

Rebound is predictable. Experienced nozzlemen use techniques to limit rebound development and remove rebound simultaneously during shotcrete placement. Dense, well-consolidated in-place material within the footing to wall joint is essential to product quality. Professional shotcrete crews use well-proven techniques to prevent trapped rebound from accumulating within this critical area.

Fig. 2: Loose aggregates collect along the construction joint ahead of the nozzle flow

Fig. 3: Dramatic example of loose rebound trapped within a corner

Professional Nozzlemen Prevent Accumulated Rebound by:

1. **The continuous use of a blow pipe**. The continuous use of a blow pipe is by far the most efficient method to eliminate rebound from accumulating in the construction joint. Its full-time use is required in many specifications. Rebound is always created. Without a blow pipe, rebound will accumulate in the joint area and create loose lenses or pockets. Contrary to what many believe, nozzle energy itself is insufficient to remove rebound once the material initially congregates. Therefore, if rebounded material is not immediately removed by a blow pipe, it will be covered by the following stroke, permanently encasing loose, unconsolidated masses within the work. Continuously use a blow pipe to keep the bottom of the wall clean and free of rebound as the nozzleman applies shotcrete at the construction joint (refer to Fig. 4).

Fig. 4: A blow pipe operator continuously removes rebound as a nozzleman places material at the construction joint

Fig. 5: A nozzleman following a blow pipe operator and using proper techniques at the construction joint

Fig. 6: Build corners higher than adjacent areas to minimize trapped rebound

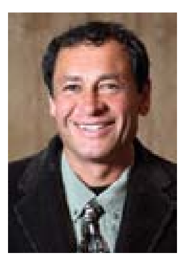
2. **Advanced nozzle techniques must be used at the joint**. Place the initial shotcrete layer by carefully developing a bench-shaped puddle of shotcrete along the bottom joint. Expert nozzlemen avoid shooting directly toward reinforcements or hard surfaces that are likely to generate excess rebound. They develop a puddle of in-place material that absorbs, rather than rebounds, the mixture's larger aggregates. Keep the nozzle close and shoot into, not away from, the puddle. Do not shoot with a nozzle angle that is perpendicular to the wall. Instead, direct the nozzle at an angle to shoot perpendicular to the puddle's receiving surface. The nozzle stream will strike the fresh puddle, not the hard surfaces of the footing or form. This nozzling technique will not eliminate rebound development but will diminish rebound dramatically. Keep an angled taper to all benched shotcrete. This will help rebound roll out, not into a wall section (refer to Fig. 5).
3. **Start in the corners first**. Work from the corners first to keep rebound and other loose material from becoming trapped. Create a bench that simultaneously works up both sides of a corner higher than the adjacent area to minimize trapped rebound (refer to Fig. 6).
4. **Properly encase water stops**. Water stops are common details at many construction joints (refer to Fig. 7). A nozzleman must exercise caution when encasing water-stop products during initial placement. Water stops can move or fold over from nozzle stream velocity. Water stops are likely to trap excessive rebound due to their location within the construction joint. Reduce air delivery at the nozzle to avoid deforming or dislodging the

water stop. Continuously blow rebound and loose materials out of the "shadow area" created by the water stop. An installation-related water-stop failure cannot be easily repaired. The nozzleman must visually validate the water stop's shape, location, and cleanliness as it is being encased.

5. **Watch your work**. Prior to placement, ensure that the footing to wall joint is free of dirt, construction debris, or standing water. Roughened surfaces in saturated surface-dry (SSD) conditions at the footing joint will promote bond of the fresh layer. During placement, use your eyes and watch for rebound accumulation and react accordingly. You are the only person who can see the material as it is placed. A skilled nozzleman's leadership skills, visual observations, and attention to details are critical at the construction joint. If rebound accumulates, direct the crew to cut suspected rebound pockets out of the fresh work and reshoot them. Skilled nozzlemen know that the bottom of a wall can be the most challenging area to correctly place shotcrete material. Specific nozzleman placement techniques to control rebound accumulation at the footing to wall joint are critical to attaining a quality product.

Poor workmanship does not simply disappear—it gets covered over. Accumulated rebound lenses at the footing to wall joint can lead to serious long-term structural issues that can come back to the shotcrete placement company as a costly repair. Fortunately, rebound-related flaws are completely avoidable through the use of proven placement techniques that effectively remove rebound and limit its development.

Fig. 7: Properly installed water-stop products are important components to wall construction designs



*ACI Certified Nozzleman **Oscar Duckworth** is an ASA and American Concrete Institute (ACI) member with over 15,000 hours of nozzle time. He has worked as a nozzleman on over 2000 projects. Duckworth is currently an ACI Examiner for the wet- and dry-mix process. He is also on the ASA Board of Direction and Chair of the ASA Safety Committee. He continues to work as a shotcrete consultant and certified nozzleman.*

Avoiding Heat-Related Illnesses

By Paul F. Ampey

Summer can be brutal on a shotcreter when outside ambient temperatures hover near or above 90°F (32°C) and the relative humidity is high. Take those factors into account with the heat that concrete gives off when curing and you have a recipe for heat illnesses if precautions aren't in place. Employers are reminded to train managers, supervisors, and employees on how to protect themselves from heat illness. All workers need to drink plenty of water and take breaks in the shade as temperatures rise.

Workers who are exposed to extreme heat or work in hot environments may be at risk of heat stress. Exposure to extreme heat can result in occupational illnesses and injuries. Heat stress can result in heat stroke, heat exhaustion, heat cramps, or heat rashes. Heat can also increase the risk of injuries in workers, as it may result in sweaty palms, fogged-up safety glasses, and dizziness.

Employers should take four basic steps at all outdoor work sites to prevent heat illness:

1. Implement a written heat illness prevention program;
2. Provide heat illness training to all supervisors and employees;
3. Make water readily available and encourage each employee to drink four 8 oz (237 mL) cups per hour; and
4. Provide access to shade or any cool area out of the sun for at least 5 minutes at a time to recover.

Here are some additional steps to take to avoid heat illness:

- *Acclimate*: New employees who are unaccustomed to working under hot conditions are the most vulnerable. They must be monitored carefully. If possible, begin work earlier in the day when it's cooler or gradually work up to a full schedule.
- *Ice It Up*: Use ice in your water and make it available for ice packs to cool the body. Potable drinking water should be available in quantities of at least one quart per employee per hour for the entire shift. Be sure to replenish the potable water containers on an effective schedule. Drinking water should be placed as close as practicable to workers and drinking containers should be kept clean.
- *Drink Up*: Encourage employees to drink frequently—an 8 oz (237 mL) cup every 15 minutes, even if they are not thirsty.
- *Drinks to Avoid*: Drinks with caffeine, alcohol, and large amounts of sugar.
- *Made in the Shade*: Make sure everyone has a place to cool off: Use pop-up umbrellas or canopies to provide a shady rest area for those who work outdoors. Sufficient shaded areas should accommodate 25% of the work force. Access to shade should be permitted at all times; encourage employees to take cool-down time periods of at least 5 minutes.
- *Hot Weather Fashion*: Avoid non-breathing synthetic clothing. Wear light-colored, loose-fitting, breathable clothing such as cotton. Also, body-cooling clothing, such as vests, leggings, and collars, helps to lower body temperature.
- *Monitor*: Implement a buddy system where workers and supervisors monitor one another.
- *Training*: Employees should be trained to recognize the symptoms of heat-related illnesses, become familiar with the appropriate first aid measures to treat them, and have a means to call emergency services.

REMEMBER: THE FIRST STEP IS PREVENTION.

Source: Cal/OSH and www.osha.gov.

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Accelerator Dosing Pump Calibration and Verification

By Lihe (John) Zhang

Accelerators are widely used for underground shotcrete applications. The most commonly used accelerator dosage ranges from 3 to 6% by mass of cementitious materials. The accelerator dosage added to the shotcrete is critical for shotcrete performance and quality. It is important to properly calibrate the accelerator dosing pump to provide a reliable accelerator supply at the designed dosage. This article compares the conventional way of accelerator dosing pump calibration with a more reliable way of accelerator dosing pump calibration.

For tunnels and mines that require overhead shotcrete application, it is essential to use an accelerator, primarily to reduce the incidence of shotcrete falloff. The dosage of accelerator added to the shotcrete is critical, as it directly affects the quality and strength development of the final shotcrete support. Too little accelerator will not be sufficient to enable the shotcrete to set within several minutes and therefore may not be effective in preventing shotcrete from falling off. Too high a dosage of accelerator will set the shotcrete within a few minutes, or even seconds, but will result in porous shotcrete with poor quality, including high permeability and low strength.

An accelerator is typically added using a dosing pump that pumps the accelerator to the nozzle at a preset dosage rate, but it can also be added as a dry powdered accelerator to prebagged dry-mix shotcrete. For wet-mix shotcrete applications, liquid non-alkali accelerators are generally used. The accelerator is supplied by a dosing pump at a design dosage rate. The accelerator hose is connected to the shotcrete nozzle and liquid accelerator is injected into the material stream at the nozzle. A control valve is connected to the accelerator hose and can be adjusted to control the accelerator dosage rate (Fig. 1). For dry-mix shotcrete application, powdered accelerators can be added to dry bagged material, or a liquid accelerator can be added to the materials at the nozzle through a dosing pump. For a non-alkali liquid accelerator, the typical dosage is about 3 to 6% by mass of cement or cementitious materials.[1]

Fig. 1: An accelerator dosing pump with control valve

Method A: Calibration of Dosing Pump by Setting Up Flow Rate

The most commonly used accelerator dosing pump calibration method is to measure the quantity of accelerator supplied by the dosing pump while the accelerator hose is not connected to the nozzle over a given period of time (for example, 1 minute). The quantity of shotcrete supplied by the shotcrete pump over the same period of time is determined by the pump production rate—that is, how many pump strokes per minute times the volume of the pump piston times the fill rate in the piston. The typical fill rate in the piston is about 90%, depending on the slump of the shotcrete mixture.

Generally, the accelerator supplier will provide a calibration flowchart for the accelerator being used based on the accelerator dosing pump flow rate and the shotcrete pump rate. The accelerator flow rate is controlled by the dial gauge or valve.

This can be simply calibrated by running the accelerator dosing pump for a fixed time (1 minute, for example) and determining the volume of accelerator being pumped out by collecting the accelerator in a graduated flask.

Method B: Calibration/Verification of Dosing Pump by Recording Actual Volume of Accelerator Added to the Shotcrete

During a number of trials, it was found that the setting time and early-age compressive strength development of the shotcrete varies from that expected from the accelerator dosages calibrated by the aforementioned Method A. The addition rate of the accelerator was carefully investigated and it was found that the dosing pump was not able to supply accelerator at a reliable feed rate, even when the dial was preset to be the designed accelerator dosage rate. The accelerator dosing pump was calibrated based on the supplier's flow rate chart method, but the actual quantity added to the shotcrete was different.

Further investigation found that with certain types of accelerator pumps, when the accelerator pump was connected to the shotcrete nozzle, the accelerator dosage rate was affected by the pressure from the compressed air added to the shotcrete at the nozzle. Thus, the actual quantity of accelerator added to the shotcrete mixture was not accurately known. For example, if the accelerator dosing pump is a peristaltic type of equipment, it can supply accelerator at a certain rate and at a certain accelerator pump pressure.[1] The supply volume might be reduced by the "back pressure" caused by compressed air during shooting.

The quantity of accelerator being added to the shotcrete has a greater potential to be excessive rather than below optimum because the shotcrete crew, including the pump operator and nozzlemen, may field-adjust the required quantity of accelerator in response to perceived conditions. It is not uncommon for the crew to increase the dosage of accelerator (sometimes excessively) when they:

- See shotcrete start to fall off or slough;
- See shining water at the surface of the shotcrete;
- Feel that the slump of shotcrete is too high; or
- Are not confident that shotcrete will stay on the wall or overhead.

Therefore, it is critical to properly calibrate the dosing pump at the very beginning of shotcrete production and verify the actual quantity of accelerator added to the shotcrete mixture. A procedure for shotcrete-dosing pump calibration and accelerator dosage verification is described in the following sections.

Equipment

1. Dosing pump: Identify maximum capacity; make marks for 4 and 6% accelerator addition by mass of cementitious materials.
2. Dosing pump hose: Ensure a 1 in. (25 mm) internal diameter; identify length of hose from accelerator container to nozzle.
3. Weigh scale.
4. Ensure dimensions of calibration box are 2 x 2 x 1 ft = 4 ft^3 (0.61 x 0.61 x 0.3 m = 0.11 m^3).

Methodology

1. Calculate the exact quantity of accelerator required. For example:
   - 4%: If 1 m^3 (35.31 ft^3) of concrete contains 410 kg (904 lb) cement, then the amount of accelerator required is 16.4 kg/m^3 (0.465 kg/ft^3) or 1.860 kg/4 ft^3 (4.1 lb/4 ft^3).
   - 6%: If 1 m^3 (35.31 ft^3) of concrete contains 410 kg (904 lb) cement, then the amount of accelerator required is 24.6 kg/m^3 (0.697 kg/ft^3) or 2.787 kg/4 ft^3 (6.1 lb/4 ft^3).
2. Have two buckets (25 gal. [95 L]) ready, with Bucket 1 half-full of accelerator and Bucket 2 full of accelerator. Weigh Bucket 2.
3. Submerge the accelerator hose in Bucket 1 (the half-full bucket). The nozzleman should then start shooting, but not into the box. This way, the accelerator hose will be filled with accelerator.
4. The engineer should give instructions to the nozzleman to shoot into one of the 4 ft^3 (0.11 m^3) boxes. At the same time, the accelerator hose must be removed from Bucket 1 and inserted into Bucket 2 (the full bucket).
5. Once the box is filled to the top with shotcrete, stop shooting and remove the accelerator hose from Bucket 2 at the same time.
6. Weigh Bucket 2 again. The difference in weight is the exact amount of accelerator added at the nozzle during shooting of the 4 ft^3 (0.11 m^3) of shotcrete.
7. Calculate the exact accelerator dosage rate as a percentage by mass of cement.

Note: The estimated time to complete calibration is about 10 minutes.

Once an accelerator pump is properly calibrated, a calibration table of the accelerator pump dial settings and shotcrete pump settings can be established. An example is shown in Table 1. With the table, it is very simple for the pump operator or nozzleman to accurately set the accelerator rate by checking the stroke rate and accelerator dial settings. This calibration table should be printed out, laminated, and attached to the accelerator dosing pump.

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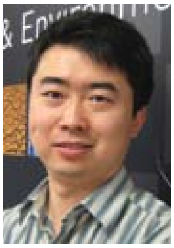
1. Millette, D., "Using Accelerators for Shotcreting," *Shotcrete*, V. 12, No. 2, Spring 2011, pp. 36-39.

Table 1: An Example Field Chart of Accelerator Dosing Rate Setting

Shotcrete pump setting		Accelerator pump dial settings		
Number of strokes per minute	**Number of m^3 (yd^3) of shotcrete per hour**	**4% by mass of cement**	**6% by mass of cement**	**8% by mass of cement**
5	2.1 (2.8)	1.2	1.3	1.4
6	2.5 (3.3)	1.2	1.4	1.5
7	3.0 (3.9)	1.3	1.5	1.7
8	3.4 (4.4)	1.3	1.5	1.8
9	3.8 (5.0)	1.4	1.6	1.9
10	4.2 (5.5)	1.4	1.7	2
11	4.7 (6.1)	1.5	1.8	2.2
12	5.1 (6.7)	1.5	1.9	2.3
13	5.5 (7.2)	1.6	2	2.4
14	5.9 (7.7)	1.7	2.1	2.5
15	6.3 (8.2)	1.7	2.2	2.7
16	6.8 (8.9)	1.8	2.3	2.8
17	7.2 (9.4)	1.8	2.4	2.9
18	7.6 (9.9)	1.9	2.5	3.1
19	8.0 (10.5)	2	2.6	3.2
20	8.5 (11.1)	2	2.7	3.4



***Lihe (John) Zhang**, PhD, PEng, LEED AP, recently opened his own firm, LZhang Consulting and Testing Ltd. Zhang has over 10 years of experience in concrete technology and the evaluation and rehabilitation of infrastructure. He received his PhD in civil engineering from the University of British Columbia, where he conducted research on fiber-reinforced concrete, and is also a LEED Accredited Professional. He is Chair of American Concrete Institute (ACI) Subcommittee 506-F, Shotcrete-Underground, and is a member of ACI Committees 130, Sustainability of Concrete; 506, Shotcreting; and 544, Fiber-Reinforced Concrete, and a member of ASTM Committee C09, Concrete and Concrete Aggregates. He is also Chair of the ASA Education Subcommittee: Graduate Scholarships, Co-Chair of the ASA Underground Committee, and an ASA Board member.*

Rusty Steel

By Alexander "Sash" Williams

Fig. 1: Reinforcing bar with minor surface rusting

If you've seen reinforcing steel, you've likely also seen rusty reinforcing steel. Is this OK? Yes, but there are limits.

Section 7.4.2 of ACI 318-11 states:

"Except for prestressing steel, steel reinforcement with rust, mill scale, or a combination of both shall be considered satisfactory, provided the minimum dimensions (including height of deformations) and weight of a hand-wire-brushed test specimen comply with the applicable ASTM specifications referenced in 3.5 (Steel Reinforcement provisions in Chapter 3 – Materials of ACI 318-11)."

The reinforcing steel found on the majority of conventional projects is likely to fall under ASTM A615 or A706. Within the body of these ASTM standards, under the heading of "Finish," the standards expand the list of acceptance criteria provided by ACI 318-11 for the weight, dimensions, cross-sectional area, and tensile properties of the reinforcing bar in question. Each standard includes a table that lists the required nominal weights and dimensions for reinforcing steel from No. 3 up to No. 18 (10M up to 57M). It's worth noting that these nominal dimensions are equivalent to those of a plain (undeformed) round bar.

How do these ASTM documents and tables help a contractor determine when a rusty reinforcing bar is acceptable to use or when an engineer has sufficient grounds to reject the reinforcing bar? The following may be a reasonable first pass: for surface rust that can be wiped off, it is almost certainly OK; if it can be brushed or scraped off and it does not leave any discernible pitting, it is likely OK; if there is scale and shows pitting of the surface when wire brushed, it likely does not meet the ASTM standards (refer to Fig. 1 to 3). If it is a questionable call, the final determination would likely have to be made by a qualified lab; however, there are alternatives. Provided the rust does not adversely affect the bond or tensile properties of the reinforcing bar, it would be reasonable to assume that a No. 5 (16M) bar with minor pitting would meet the ASTM designated criteria of a No. 4 (13M) bar, and so on. If the reinforcing bar is already installed, the engineer could consider allowing the contractor to add supplemental reinforcing bar to compensate for cross section reduced by rusting.

It is valuable to point out that rust can actually increase the bond between reinforcing steel and concrete. Deformed reinforcing steel is manufactured with deformations in the form of patterned ridges to increase the surface roughness, leading to an increase in the bond as compared to a plain bar. Surface rusting increases the roughness of the reinforcing bar and, in doing so, rust can increase the bond. This should not in itself be considered a valid argument for using rusty reinforcing steel. The design equations using bond between reinforcing steel and concrete, such as the calculation of reinforcing bar development length, do not include a variable for rusting. Any additional bonding that could be attributed to the rust would be supplemental to what was already determined to be necessary.

Fig. 2: Reinforcing bar with surface rusting and the beginning of rust scale

Fig. 3: Reinforcing bar with surface rust and scale

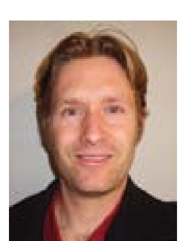
According to ACI and ASTM standards, the presence of rust alone is not sufficient grounds for rejection. For situations where the rust has progressed beyond surface rust, there may be some judgment needed in the field by both the contractor and engineer. Ultimately, the best scenario is a project where proper material handling and storage leads to reinforcing bar with nothing more than the occasional areas of surface rust.

References

ACI Committee 318, "Building Code Requirements for Structural Concrete (ACI 318-11) and Commentary," American Concrete Institute, Farmington Hills, MI, 2011, 503 pp.

ASTM A615/A615M-12, "Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement," ASTM International, West Conshohocken, PA, 2012, 6 pp.

ASTM A706/A706M-09b, "Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement," ASTM International, West Conshohocken, PA, 2009, 6 pp.



Alexander "Sash" Williams *is a licensed professional engineer; an ASA, American Concrete Institute (ACI), and ASCE member; and President of Williams Associates Engineering, Inc., in northern California. Williams specializes in temporary and permanent earth retention design, including wine caves in California.*

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 Web site at **www.shotcrete.org/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%** (see below).
7. Speed of repair reduces or eliminates downtime.
8. Better bonding to the substrate, which enhances durability.
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.

New Construction Speed Savings of 33 to 50%

Both cars looked the same. When asked why one was more expensive, the salesman had no explanation. "They are the same, one just costs more," he replied. When we buy automobiles, we expect to pay more for a superior product. We hunt out value by purchasing certain brands that possess attributes such as quality or durability. To the car buyer, two identical cars should cost the same amount.

In the construction industry, costs may vary based on intangibles that may be difficult to initially understand. Obviously, most would be unhappy to realize that they have paid substantially more for an identical product, but this is a common scenario. Concrete is the most common construction material on the planet, but its installed cost will never be the same. The speed and efficiency with which concrete can be placed will determine its installed cost.

The Magic of Shotcrete Efficiency

Since the first use of concrete, it has been cast into forms. Even today, almost all concrete produced is ultimately cast in place. Currently, shotcrete placement methods are capable of creating virtually the same in-place product as traditional cast-in-place concrete construction, but in many applications, shotcrete construction methods are much more efficient than conventional cast-in-place concrete construction. If asked, however, many construction professionals may not be able to clearly explain why.

The "magic" that explains this unique placement method's efficiency is the nearly nonexistent fluid pressures applied to vertical forming materials during shotcrete placement. Shotcrete is not cast in a fluid state. Therefore, vertical forming materials need only be sufficiently rigid to initially stop the impact of nozzle flow at the receiving surface.

Shotcrete Methods That Save Time

For decades, tunneling, earth retention, and concrete repair contractors have used shotcrete placement methods to speed production. Today, more conventional concrete projects are switching to shotcrete placement methods to save time. A good example is the remodeling of commercial and industrial concrete structures. Window and door infills are regularly formed, placed, and completed on a single overnight shift. Structural improvements, seismic retrofitting, and shear elements commonly use shotcrete to save time. A very common method for seismic upgrading of existing structures is the addition of concrete shear walls. The lack of form pressure from fluid concrete liquid head allows the shotcrete method to often use existing structures as the back form. Many unreinforced masonry buildings can be restored by adding shear walls to the existing structure with very little, if any, added forming. In this same way—that is, using existing surfaces—sea walls, water canals, and erosion control construction are also expedited by the use of shotcrete. On average, shotcrete placement techniques can yield 33 to 50% time savings over traditional cast-in-place methods.

Alternative Shotcrete Form Materials Speed Production

Many shotcrete contractors speed production by using alternative forming materials. Light-grade steel studs, commonly used for commercial and industrial wall framing, provide adequate rigidity as form framing, and standard interior-grade gypsum drywall or expanded metal lath sheets work well as an alternative to plywood or dimensional lumber panels (Fig. 1). Unacceptable to withstand internal casting pressure, as traditional forming materials must, alternative shotcrete forming materials provide unparalleled construction speed. They are tougher than they look! Lightly framed vertical walls higher than 20 ft (6.1 m) can be placed without special precautions. Alternative form materials are proven to dramatically speed production with no compromise in product quality.

There are also times when traditional forming materials cannot be used because of the configuration. The Experienced Music Project (Fig. 2) built in 2000 in downtown Seattle, WA, is an example where forming and cast-in-place methods simply would not work. Using shotcrete placement and a stay-in-place forming system allowed for the construction of an irregular-shaped, 5.5 in. (140 mm) structural concrete shell over 100,000 ft^2 (9300 m^2) in size.

A Closer Look Reveals More Time Savings

Are low material costs and ultra-fast construction not enough? Alternative shotcrete forming techniques are enormous time savers when compared to conventional retaining wall methods. Traditionally designed as a cast-in-place application, concrete walls constructed against earth embankments require substantial over-excavation to allow safe access to both sides of the wall for construction and removal of forming materials. Although some walls may be shot directly against earth surfaces, common construction details typically require the installation of drainage and waterproofing membranes. Taller walls constructed near excavated earth can become dangerous, creating confined space hazards to workers who can become trapped behind walls in the event of earth movement. Current construction standards mandate that tall concrete walls within close proximity to unsecured earth embankments cannot safely and legally be conventionally constructed without extensively over-excavating the slope or using temporary earth-shoring methods.

Alternative wall-forming techniques can allow shotcrete walls to be safely erected near most earth embankments because the forming system is designed to stay in place. After placement, the wall is simply backfilled with a drainage material. This eliminates the need to place workmen at risk

Fig. 1(a) and (b): Forming techniques that use alternative materials

Fig. 2: Experienced Music Project, Seattle, WA, 2000

Fig. 3: *Nine-foot (2.7 m) tall wall constructed near excavated earth bank. Note drainage and waterproofing membranes applied to face side of form*

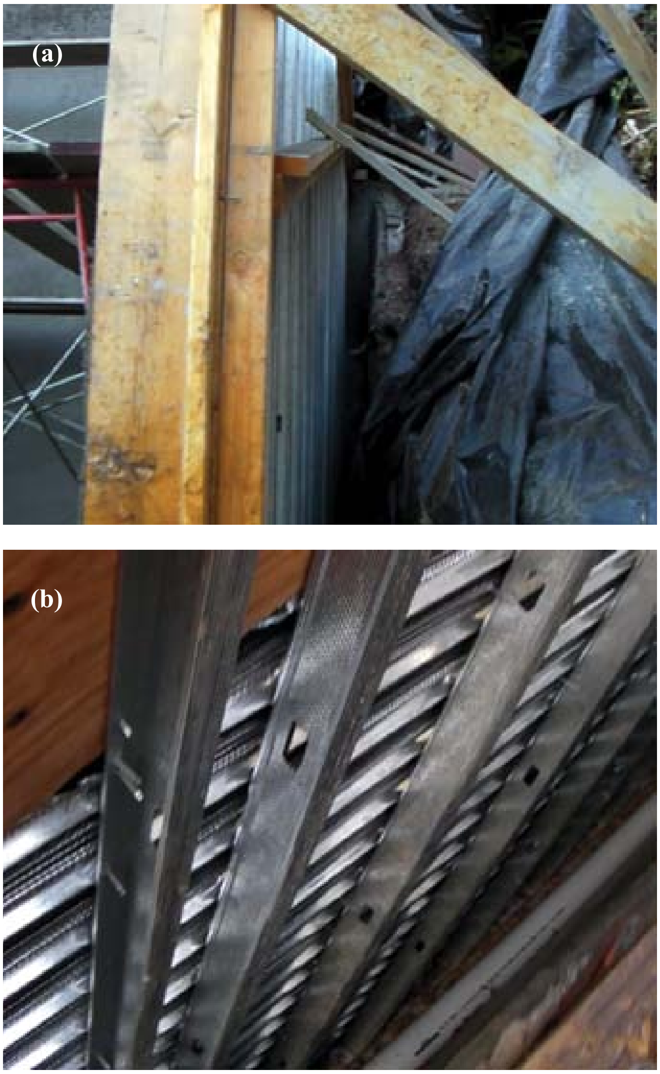


Fig. 4(a) and (b): Back side view reveals minimal over-excavation. Alternative form materials will remain in place

when working between the embankment and the completed wall. All required drainage or waterproofing membranes are incorporated into the face side of the formwork, prior to placement, and will remain in place, undisturbed, and protected by the form materials during backfilling (Fig. 3 through 5).

The use of stay-in-place forming techniques nearly eliminates costly over-excavation, haul-off, and recompaction, while providing identical performance to traditionally constructed concrete. Innovative shotcrete techniques consistently generate speed savings of 33 to 50% over conventionally cast-in-place concrete. Speed and efficiency directly influence the concrete's final cost. Less formwork, labor, and time also significantly enhance the project's sustainability. Like the two cars, similar products can have vastly different final prices.

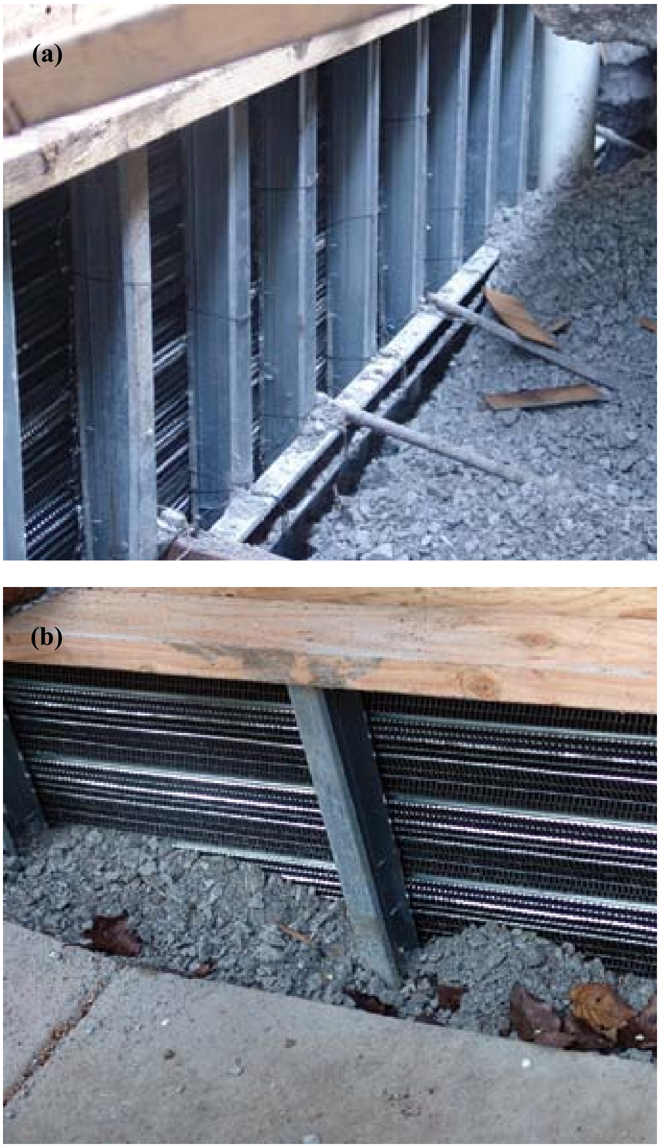
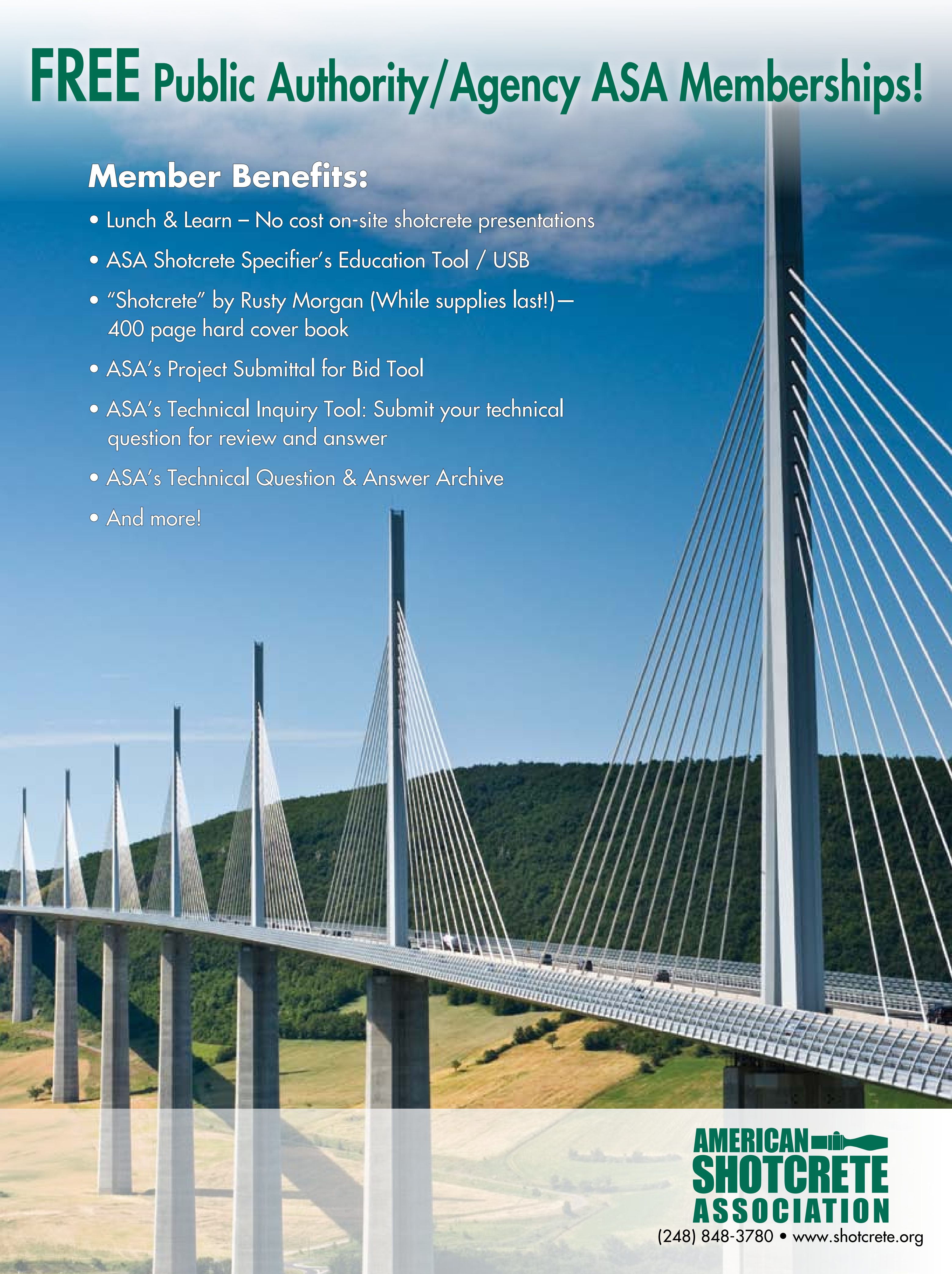


Fig. 5(a) and (b): Completed wall after backfilling with drainage material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Preprufe® SCS- membrane installation

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Web site: **www.na.graceconstruction.com**

Shotcrete Calendar

JULY 8-12, 2012
TSP·2—AASHTO Subcommittee on Bridges and Structures
Hyatt Regency Austin
Austin, TX
Web site: **www.transportation.org**

JULY 25, 2012
SDC Vision 2020 Workshop
SpringHill Suites Chicago O'Hare
Chicago, IL
Web site: **www.concretesdc.org**

SEPTEMBER 17-18, 2012
TSP·2—2012 Northeast Bridge Preservation Partnership Annual Meeting
Newport, RI

OCTOBER 16-18, 2012
TSP·2—2012 Midwest Bridge Preservation Partnership Annual Meeting
Council Bluff, IA

OCTOBER 20, 2012
ASA 2012 Fall Committee Meetings
Sheraton Centre
Toronto, ON, Canada

OCTOBER 21-25, 2012
ACI Fall 2012 Convention
Theme: "Forming Our Future"
Sheraton Centre
Toronto, ON, Canada
Web site: **www.concrete.org**

NOVEMBER 6-7, 2012
ASA Shotcrete Nozzleman Education Session
Tuesday, 11/6 | 3:00 pm-6:00 pm
Wednesday, 11/7 | 8:00 am-12:00 pm
Registration will open in late June
Morial Convention Center
New Orleans, LA
at the 2012 International Pool | Spa | Patio Expo

NOVEMBER 6-8, 2012
2012 International Pool | Spa | Patio Expo
Visit ASA at Booth #2537
Morial Convention Center
New Orleans, LA (New location!)
Web site: **www.poolspapatio.com/attendee**

NOVEMBER 7-9, 2012
ICRI 2012 Fall Convention
Theme: "Life Cycle Repair—Sustainability"
Rancho Las Palmas Resort & Spa
Ranchero Mirage, CA
Web site: **www.icri.org**

DECEMBER 2-5, 2012
ASTM International Committee C09, Concrete and Concrete Aggregates
Hyatt Regency Atlanta
Atlanta, GA
Web site: **www.astm.org**

FEBRUARY 4, 2013
ASA WOC 2013 Committee Meetings
Las Vegas Convention Center
Las Vegas, NV

FEBRUARY 5, 2013
ASA Eighth Annual Outstanding Shotcrete Projects Awards Banquet
Venue to be Determined
Las Vegas, NV

FEBRUARY 5-8, 2013
World of Concrete 2013
Seminars: February 4-8, 2013
Exhibits: February 5-8, 2013
Visit ASA at Booth #S11429—NEW LOCATION!
Las Vegas Convention Center
Las Vegas, NV
Web site: **www.worldofconcrete.com**

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
Web site: **www.smenet.org**

MARCH 20-22, 2013
ICRI 2013 Spring Convention
ICRI Celebrates its 25th Anniversary—"Looking Ahead"
Tradewinds Islands Resorts
St. Pete Beach, FL
Web site: **www.icri.org**

Shotcrete Calendar

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
Web site: **www.concrete.org**

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

NOVEMBER 13-15, 2013
ICRI 2013 Fall Convention
ICRI Celebrates its 25th Anniversary—"Looking Back"
Fairmont Chicago
Chicago, IL
Web site: **www.icri.org**

AMEC Awarded 2011 National Safety Excellence Award

ASA Corporate Member AMEC, the international engineering and project management company, has been awarded a 2011 National Safety Excellence Award from Associated Builders and Contractors, Inc. (ABC). The award was presented during the 22nd Annual Excellence in Construction banquet at ABC's premier event, BizCon.

ABC is a national association with 74 chapters representing nearly 23,000 merit shop construction and construction-related firms with nearly 2 million employees. The ABC National Safety Excellence Awards recognize companies that strive to maintain outstanding safety programs, policies, and procedures. Award categories are based on a company's total work hours per calendar year and placement within the North American Industry Classification System (NAICS).

"ABC congratulates AMEC for its proven dedication to construction workplace safety," said ABC President and CEO **Michael Bellaman**. "It is a pleasure for the association to honor this company's high achievement with our National Safety Excellence Award."

AMEC's safety performance is a critical factor of the company's success, and an operation is not seen as successful unless it is delivered safely. AMEC's vision is to achieve sustainable world-class health and safety performance across its global operations. As part of that vision, it is paramount that every employee holds safety as a cultural value and believes that all injuries are preventable, employees can work safely, the environment should be protected, and the company is being led to a sustainable future.

"We are delighted to be honored with this award for our enduring commitment to safety," said **Tim Gelbar**, President of AMEC's Power & Process Americas business. "Working safely yields better outcomes and clients have come to associate AMEC with safe delivery. As AMEC continuously strives to achieve world-class safety performance, we must not lose sight of our vision on safety, nor should we forget to practice safety in every moment. Nothing is so important that we cannot take the time to do so safely."

Contech Announces New Ownership Structure and New Corporate Name

Contech Engineered Solutions LLC (formerly Contech Construction Products Inc.), a leading provider of innovative engineering and site solutions for the residential, commercial, and infrastructure markets, has announced several positive developments that position the company for the future.

Contech has announced that it has new ownership in place—equity investors that include Anchorage Capital Group, LLC; Littlejohn & Co., LLC; Tennenbaum Capital Partners, LLC; and Farallon Capital Management, LLC. These investors have worked with Contech, its equity partners, and its senior lenders to recapitalize the company and secure long-term financing. Contech also announced that, as a result of its growth in new markets and geographies and the buildout of its product lines for the residential, commercial, and infrastructure markets, it has changed its corporate name to Contech Engineered Solutions LLC, effective immediately.

"We believe this new name more accurately reflects who we are today. We do more than just provide construction products—we provide innovative engineering and site solutions for world-class customers. We remain laser-focused on delivering the best customer experience while providing the market with sustainable site solutions. Our commitment to go beyond customers' expectations with excellent product quality and reliability, combined with superior ongoing service and support, is the Contech difference," said **Ron Keating**, Contech's President and Chief Executive Officer.

Additionally, Contech announced that it secured new long-term financing and entered into a new credit facility with Wells Fargo Bank N.A. (Administrative Agent) in the aggregate principal amount of $125 million, as well as a revolving loan commitment of up to $100 million. As part of the new financing agreements, new ownership structure, and Contech's ongoing capital improvement initiatives, it has successfully removed 100% of its past revolving and term loan obligations.

"This is yet another significant milestone for our company, as we now have the capital structure to execute on our strategy of enhancing our product and service offerings and building our market leading positions across the globe. Over the past 2 years, we have successfully removed over $600 million of debt and have created almost $100 million of liquidity under our new revolver. We have the necessary resources to grow and the commitment from leadership to deliver the best customer experience in the industry," Keating concluded.

Genesis 3, Inc., Holds a Summit Meeting with Members and Sponsors

Genesis 3 recently hosted its first-annual Educational Summit meeting, where Gold, Platinum and Society of Watershape Designers (SWD) members, as well as sponsors, gathered at the Riviera Palm Springs Hotel in Palm Springs, CA.

The meeting, which was also presented in a WebEx format online, covered recent changes within the Genesis 3 structure. These changes include the roles that the Platinum Advisory Board and Education Council will play moving forward; association synergy plans with Hanley Wood, AIA, ASLA, APLD, and media publications; and a renewed collective focus among partners on students and sponsors.

Dave Peterson, PE, SWD, and Education Chairman, unveiled the new "Genesis 3 University" document, which outlines Genesis 3's plans to offer industry-leading programs from this point forward. The new programs and overall structure embody the Genesis 3 philosophy of education, certification, and connection. Genesis 3 University will reach watershape professionals through coursework, projects, examination, and continuing education. The connections are not only with like-minded professionals within the Genesis 3 family but also with its network of Platinum, Gold, and Silver sponsors.

"We've recently restructured our education system in preparation for a growth spurt," said Peterson, "actually doubling the number of program offerings. We've scheduled more classes in the next 12 months than we have held in the last 2 years. Our existing programs are also being updated to make them more relevant to the watershaping industry. Plus, we are moving our exams online to free up more classroom time for valuable instruction. We also developed a new Education Council comprised of distinguished professionals that understand the industry, as well as the need for education."

Members of the newly created Education Council are **Chuck Hess**, L.A., of Chuck Hess Landscape Architects; **Helena Arahuete**, Architect, Lautner Associates; **Bill Drakeley**, member and Liaison to the Advisory Board; **Brian Van Bower**; **Skip Phillips**; and Chairman **Dave Peterson**, PE, member and representative from the engineering field.

Genesis 3 seeks to bring design, engineering, and construction excellence to the watershaping industry by offering seminars, short courses, and schools that reflect the education, experience, and applied skills of top flight instructors working with first-class ambition.

For more information, please visit **www.genesis3.com**.

Introducing PULLMAN

The brand name PULLMAN has been created as a unifying identity for sister companies Pullman Power, LLC; SPS Infrastructure, Inc.; and Shared Systems Technology, Inc. PULLMAN companies combine specialty construction and maintenance services with proprietary technology to solve engineering and construction challenges.

"The driving force for our new brand was our customers," said **Ken Chodnicki**, Chief Sales and Marketing Officer. "We were asked to clarify the multitude of brands and company names we have and deliver our capabilities to them under a single organization."

"Although the name has changed, what our clients have come to know and expect remains the same," commented **Bob Duncan** of PULLMAN. "Together, all PULLMAN resources bring industry-leading expertise and experience, advanced technologies, and the highest commitment to quality and safety."

JJA Earns Top Family Business in Silicon Valley

Jos. J. Albanese, Inc. (JJA), has been recognized as the largest family business (in terms of employees) in Silicon Valley for the second straight year. The March 16, 2012, *Silicon Valley Business Journal* highlighted the top family businesses in the area. **John Albanese**, second-generation President/CEO, is not necessarily one for such rankings but does recognize that the success these represent come only from the people who make up the team. Albanese is proud of the JJA team and is looking forward to continuing to build on the core family values that have been the foundation of JJA, since its beginning days 57 years ago—integrity, dedication, hard work, and results.

SDC Seeks New Concrete Technologies to "Showcase" at Upcoming Sessions

The concrete industry's Strategic Development Council (SDC), a Council of the ACI Foundation, is currently seeking presentations for future sessions.

"Presenting a new technology to the Strategic Development Council allows the creators to showcase their technologies to some of the most influential leaders in the concrete industry," said **Mike Schneider**, Chair of SDC. "With the help of SDC, technologies are readied to be pushed out into the marketplace more efficiently and effectively, resulting in a higher level of exposure for the technology and its creator."

"Technology Showcases" have become a hallmark of SDC's annual spring and fall sessions, allowing companies and/or individuals the opportunity to showcase their new, interesting, innovative technologies that have the potential to improve and advance the concrete industry. Each new technology that is introduced at SDC gains exposure and possible assistance to address barriers and obstacles that are preventing or slowing acceptance of the technology within the concrete industry.

What options are pursued within SDC is primarily driven by the technology owner acting as champion and subject to the interest in the topic by the overall SDC membership. As technologies work through the SDC progression, they attain various status levels within the organization: Early Technologies, Emerging Technologies, Industry Critical Technologies, Focused Technologies, and Archived Technologies.

For more information and to submit your technology for consideration, please visit **www.concreteSDC.org** and click on "Introduce your Technology."

Industry Personnel

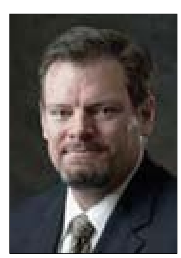
WEC Welcomes Rich Adams to Engineering Staff

Rich Adams

Rich Adams brings a wealth of experience to Wurster Engineering and Construction's (WEC) operations and becomes their fourth professional engineer, all with backgrounds in geotechnical and mining engineering. WEC specializes in design/build and geotechnical construction, including soil nail walls, micropiles, tieback anchors, slope stabilization, rock and ground anchors, shotcrete, and grouting.

ASA Corporate Member WEC was started in 1997 by **Daryl Wurster**, PE.

Hayward Baker Promotes Dennis Boehm



Dennis W. Boehm

Hayward Baker Inc. has announced the promotion of **Dennis W. Boehm** to Vice President. Boehm continues in his role as the Chief Engineer for the company's Central Region, where he heads up a team of specialists responsible for the design and estimating of various ground-modification projects in the region's challenging soil profiles. He is based out of the company's Gulf Coast Area Office in Houston, TX.

Boehm has over 25 years of engineering design, supervision, and on-site project management experience. He has been with Hayward Baker since 1990. Prior to his most recent promotion, Boehm served as a Chief Engineer and Area Manager for the company's Central Region, where he has been involved in many noteworthy ground-modification initiatives. These include projects for the Houston International Airport; Corpus Christi Naval Air Station; Cottonwood Power in Beaumont, TX; and Kraft Foods in Russellville, AK.

Prior to joining Hayward Baker in 1990, Boehm worked for PRESCON Corporation in the heavy construction industry. He received his BS in civil engineering from Texas A&M University, College Station, TX.

Commenting on the promotion of Boehm, **Steve Scherer**, Senior Vice President for the Central Region, stated, "Dennis's strong history with Hayward Baker, as evidenced by his long résumé of managing successful projects, is noteworthy. He is a specialist in jet grouting, soil mixing, and most other Hayward Baker services; and his expertise makes him a key resource for other Hayward Baker engineers in dealing with the challenges involving these services—both in the Central Region, as well as companywide. He is a tremendous asset to the company."

Lafarge Names New CEO for U.S. Operations

Global building materials supplier Lafarge has appointed **John Stull** as President and CEO, United States, putting him in charge of all aggregate, cement, and concrete operations in the United States.

The appointment now brings these Lafarge business lines in the United States together under a single leader, which the company said will focus its delivery on sustainable solutions to the construction industry.

Stull has more than 20 years of experience with the Lafarge Group, including assignments in the United States and Paris. Most recently, he managed Lafarge Group businesses in Latin America and Sub-Saharan Africa. He received his chemical engineering degree from the University of Akron, Akron, OH, and is a graduate of the Executive Management Program at Harvard Business School, Boston, MA.

ACI Announces New Officers for 2012

The American Concrete Institute (ACI) introduced its 2012-2013 President, Vice President, and four Board members during the ACI Spring 2012 Convention in Dallas, TX.

James K. Wight, Professor of Civil Engineering at the University of Michigan in Ann Arbor, MI, was elected to serve as President of the Institute for 2012-2013.

William E. Rushing Jr., Vice President with Waldemar S. Nelson & Co., Inc., in New Orleans, LA, has been elected ACI Vice President for a 2-year term, and **Anne M. Ellis**, Vice President of Government Initiatives at AECOM in Arlington, VA, is now the Institute's Senior Vice President, which is also a 2-year term.

Additionally, four members have been elected to serve on the ACI Board of Direction, each for 3-year terms: **Roger J. Becker**, Managing Director of Research and Development for the Precast/Prestressed Concrete Institute (PCI), Chicago, IL; **Jeffrey W. Coleman**, FACI, a licensed professional engineer and an Attorney at Law and Principal Partner in the law firm of Coleman, Hull & van Vliet, PLLP, Minneapolis, MN; **Robert J. Frosch**, FACI, Professor of civil engineering at Purdue University, West Lafayette, IN; and **Steven H. Kosmatka**, FACI, Vice President of Research and Technical Services at the Portland Cement Association (PCA), Skokie, IL.

Passing of Jan A. Blanck

Jan A. Blanck

Jan A. Blanck, 74, of Annapolis, MD, died May 6, 2012, at his home in the Heritage Harbor community. Blanck was born on July 20, 1937, in Stockholm, Sweden, to Ake Blanck and Gunvor (Hall) Blanck. He received his degree from Stockholm Technical College in civil engineering, becoming a recognized authority on shotcrete practices and tunnel engineering. His career as an engineer, consultant, and independent contractor reflected a know-how and a commitment to professionalism acquired over more than 40 years of progressive experience with shotcreting, drilling and grouting, tunneling, and structural rehabilitation.

Blanck was a seasoned specialist on several heavy-construction shotcrete projects in Africa and Hong Kong before coming to North America. He served as a shotcrete specialist consultant in 1967 on the first large aggregate shotcrete project in North America—the Canadian National Railway Tunnel, Vancouver, BC, Canada. The success of shotcrete on this project led to the acceptance and the use of shotcrete for tunnel support in the United States. He continued to pioneer and supervised the first use of structural shotcrete in the United States at the California Tehachapi Tunnels in 1967.

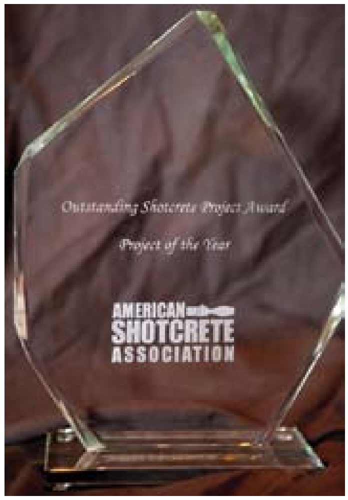
In the 1970s, Blanck came to the Washington, DC, area to open the Washington office of the A.A. Matthews Corporation and lent his shotcrete expertise to the Rock Creek Park Metro project. He also served as the project engineer on the DuPont Circle Metro project.

In the 1980s, Blanck established his own company, the J.A. Blanck Company. He continued working on metro projects but also worked on a wide range of construction projects, such as the Fire Island rehabilitation project, on Fire Island, NY; the Rock Creek Park Zoo Tunnel rehabilitation project in Washington, DC; and the Yankee Pier rehabilitation project on Governor's Island in New York City.

In the mid-1990s, after "retirement," Blanck continued consulting on various projects in South Africa, Puerto Rico and, later, in Australia. Up until 2 years ago, in 2010, he worked in New York City on the East River Tunnel project.

He will be remembered and remain highly respected for his outstanding leadership and contributions in shotcrete practices and tunnel engineering. He contributed at shotcrete and engineering geology conferences in the United States, Europe, and People's Republic of China. His credits included assisting with research projects published for the U.S. Department of Transportation.

Submit your Project for the ASA Outstanding Shotcrete Project Awards



The 8th Annual ASA Outstanding Shotcrete Project Awards are now open and projects can be submitted until **October 1, 2012**.

Pursuing an ASA Outstanding Shotcrete Project Award is a smart move not only for your organization but also for the shotcrete industry. The ASA award program offers your organization a unique and unmatched amount of exposure. In addition, the awards program and the annual awards issue of *Shotcrete* magazine are very important tools used to inform and educate the construction world about the many benefits of the shotcrete method of placing concrete.

Use the streamlined and simple online application form to submit your project today at **www.shotcrete.org/asaoutstandingprojects.htm**.

Two ASA Nozzleman Education Sessions Offered at Upcoming National Trade Shows

ASA Nozzleman Education Sessions are designed for shotcrete nozzlemen, individuals involved with shotcrete inspection, and anyone interested in learning the principles and practices a nozzleman must employ to successfully use the shotcrete process.

ASA Nozzleman Education Sessions present an overview of placement techniques, finishing, curing, testing, equipment, and safety as they relate to the nozzleman and the shotcrete process. They also prepare individuals for participation in the ACI Nozzleman Certification Program.

Program criteria, including the ACI required work experience, the written exam, and the performance exam, will be discussed. CP-60 (09), "Shotcrete Nozzleman Craftsman Workbook," for ACI Certification is included with the session registration fee.

Please note:

- Session attendance alone **will not** result in ACI Shotcrete Nozzleman certification.
- This session **will** satisfy the **education session requirement** for a nozzlemen wishing to pursue certification as an ACI Shotcrete Nozzleman through ASA.
- **Attendees who wish to pursue ACI Certification will need** to arrange for a separate certification session with ASA that includes the ACI written and performance exams.
- Attendees **will** qualify for and receive a complimentary 1-year ASA Nozzleman Membership.

2012 International Pool | Spa | Patio Expo

November 6-7, 2012, New Orleans, LA

This ASA Nozzleman Education Session will span 2 days: Tuesday, November 6, from 3:00 pm to 6:00 pm and Wednesday, November 7, from 8:00 am to 12:00 pm.

Instructor: William Drakeley, ASA Board member, ASA Pool & Recreational Shotcrete Committee Chair, ACI Approved Examiner and Certified Nozzleman

Level: 300; Hours: 7 Technical Credit Hours

The individual registration fee prior to September 20, 2012, is $259 U.S., and then it increases to $345 U.S. (fee includes materials provided by ASA).

For more information and to register, visit **www.poolspapatio.com** or the calendar on the ASA Web site at **www.shotcrete.org/asacalendar.htm**.

World of Concrete 2013

February 2013, Las Vegas, NV

As of this printing, specific dates, times, and registration fees were not yet finalized. Please visit the calendar on the ASA Web site at **www.shotcrete.org/asacalendar.htm** for details.

ASA Graduate Scholarship Program Open

ASA is now accepting applications for Graduate Scholarships for the 2012-2013 academic year. The purpose of the ASA Graduate Scholarship Program is to attract, identify, and assist outstanding graduate students pursuing careers in the concrete industry with a significant interest in the shotcrete process.

One scholarship will be awarded to a graduate student attending an accredited college or university within the United States and a second scholarship will be awarded to a graduate student attending an accredited college or university within Canada.

Based on essays, submitted data, and references, the ASA Scholarship Committee will select scholarship recipients who appear to have the strongest combination of interest and potential

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www.shotcrete.org RESOURCE REMINDER

Outstanding Shotcrete Project submittal
www.shotcrete.org/asaoutstandingprojects.htm

List of upcoming ASA events and shows
www.shotcrete.org/asacalendar.htm

Graduate Scholarship information and requirements
www.shotcrete.org/asascholarships.htm

2013 *Shotcrete* magazine Media Kit
www.shotcrete.org/pdf_files/2013ASAMediaKit.pdf

for professional success in the shotcrete industry. Each ASA Graduate Scholarship Award consists of a stipend of $3000 (USD) and is paid in one (1) installment of three thousand dollars ($3000 USD) directly to the student's educational institution.

Applications and all required documents must be received by 5:00 pm (EST) on **November 2, 2012**.

All application information and requirements can be found at **www.shotcrete.org/asascholarships.htm**.

2013 *Shotcrete* Magazine Media Kit Now Available

With a readership of over 17,000 across more than 100 countries, *Shotcrete* magazine reaches the shotcrete industry like no other resource. Advertising rates for this specifically targeted medium are very reasonable and well below the average rate for other publications in the concrete industry. This combination of exceptional access at affordable rates provides the shotcrete industry with an important and usable tool for promoting your products and/or services.

For more information, visit **www.shotcrete.org/pdf_files/2013ASAMediaKit.pdf** or call (248) 848-3780.

ASA Fall Committee Meetings in Toronto, October 20, 2012

The ASA Fall 2012 Committee Meetings in Toronto, ON, Canada, will be held at the Sheraton Centre Toronto Hotel on October 20, 2012.

The following committees have scheduled working meetings: ASA Executive Committee, Publications Committee, Pool & Recreational Shotcrete Committee, Education Committee, Safety Committee, Sustainability Committee, Marketing & Membership Committee, and the ASA Board of Direction.

These meetings offer participants the opportunity to network with colleagues, provide input on shotcrete materials and publications, and become a part of ASA's overall mission.

The ASA committee meetings are held in conjunction with the ACI Fall 2012 Convention but do not require ACI convention registration. ASA meetings are open and free to anyone with an interest in the shotcrete process.

Scheduled times for all meetings can be found at **www.shotcrete.org/asacalendar.htm**.

NOTE: If you will be flying to Toronto from the United States, a current passport will be required.

Have YOU Visited the ASA Web site Lately?

There have been significant changes and new services added!

FEATURES —

- ASA Buyers Guide
- Technical Inquiry Submission
- Submit Project For Bid
- *Shotcrete* magazine Archive
- Outstanding Shotcrete Project Awards
- Products
- Education
- Certification
- And Much More

AMERICAN SHOTCRETE ASSOCIATION

WWW.SHOTCRETE.ORG

Putzmeister Underground Division Presents Its Latest Equipment as a Complete System for Shotcreting in Mining

SPM 4210 WETKRET: Latest series of concrete-spraying equipment for mining

With the SPM 4210 WETKRET series, Putzmeister has reached a new stage in the development of concrete-spraying equipment for mining. The reinforced spraying arm, designed and manufactured by Putzmeister, provides a vertical spraying reach of 10 m (33 ft); the maximum concrete output of the Putzmeister double-piston pump mounted on the equipment is 20 m^3/h (706 ft^3/h). The proportional remote control, which can be operated both by cable and wirelessly, allows for the easy operation of the spraying arm, as well as the regulation of the concrete output and the adjustment of the predefined additive dosage. With state-of-the-art axles and a reinforced turning system, the SPM 4210 WEKTRET series is suitable for the rough working conditions in mines.

To facilitate its use in any working environment, the SPM 4210 WETKRET series includes three different versions that are designed in accordance with different job-site requirements. The standard version, SPM 4210 WETKRET, is electrically operated and includes an on-board, electrically or diesel-driven air compressor. If required, the machine is also available without an air compressor. The SPM 4210 WETKRET DUAL DRIVE version has a dual operating system so that all the components can be operated by diesel or electrically. The equipment is available with an on-board, electrically or diesel-driven air compressor. The 4210 WETKRET ROTOR version works with a rotor pump so that the equipment can be used for both the wet- and dry-spraying process. This version also includes an on-board air compressor.

Launch of Putzmeister MIXKRET 4: New low-profile concrete mixer for mining

The new low-profile concrete mixer Putzmeister MIXKRET 4 has been designed to complement and improve the concrete-spraying process in mining. It provides a concrete transport capacity of 4 m^3 (141 ft^3) and includes a liquid additive tank for transporting and transferring additives to the shotcrete equipment. The machine is equipped with a six-cylinder, 130 kW (176 hp) engine, which provides it with a great climbing and moving power as well as the possibility to work at high altitudes. The cabin, mounted in machine direction, and the night-vision camera at the rear facilitate its maneuverability and ensure good visibility at all times. Its compact design and state-of-the-art axles, both used for steering and driving, provide excellent mobility and maneuverability in narrow galleries and tunnels. The machine has hydrostatic transmission with a stepless variable gear motor, which ensures an ideal torque:speed ratio. Furthermore, the MIXKRET 4 features an automatic speed control system for moving down slopes fully loaded at the maximum secure speed.

For more information, visit Putzmeister's Web site at **www.shotcrete.putzmeister.es**.

Second Norwegian Manufacturer of Tunnel Shotcrete Robots Begins Using Olin Ball Valve Pumps

Over 6 years after switching to Olinpump S-Tube Shotcrete Pumps, AMV, a 150-year-old tunnel equipment manufacturer, has begun incorporating Olinpump's 5 65 ball valve pump into its shotcrete robots. This follows the lead of Snemyr & Limm, which has been using Olinpump in its robots for over 15 years and switched to ball valve pumps over 6 years ago. The lower cost and maintenance, combined with the absolute continuous flow of material, means consistent test breaks, resulting in great savings for the tunnel contractor. Currently, three Scandinavian OEMs use Olinpumps, supplying companies such as LNS, one of the world's largest tunnel and mining contractors.

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

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 Web site, **www.shotcrete.org/ASAfaqs.htm**.

Question: Is shotcrete used as a canal liner?

Answer: Shotcrete has been used for canal lining throughout the United States. The Bureau of Reclamation published a study on Canal Lining Test Sections constructed in the Bend, OR, area and studies the durability at 5 and 10 years. Shotcrete is a very viable means of placing canal linings. Basically, shotcrete is a method of placing concrete. Care should be taken to ensure that the mixture is designed to withstand the local environmental conditions, such as using air-entraining admixtures to ensure durability due to exposure to freezing and thawing. ACI 506R-05, "Guide to Shotcrete," contains a lot of useful information in evaluating and using shotcrete in a variety of applications, including canal linings. If liquid-tightness and long-term durability of the canal lining are important, provisions of ACI 350/350R-06, "Code Requirements for Environmental Engineering Concrete Structures and Commentary," should also be considered in the design of canal lining reinforcement, cover, and joints.

Question: Are there tolerance standards for the use of shotcrete in pool construction? For example, in regard to the pool depth, what is the accepted variation from the depth specified?

Answer: We are not aware of specific tolerances for shotcrete in swimming pools. Shotcrete is a method of placing concrete and the cover over reinforcing steel should be the same as that for cast concrete. With respect to the depth of the pool, this would be a building code issue, not a shotcrete issue.

Question: An artist we have commissioned will be using gunite for the creation of a large-scale geode-inspired sculpture. There is some concern from the community about vandalism, specifically graffiti. Do you recommend sealing or applying anti-graffiti coating to gunite? If so, what brand of sealant or coating do you recommend?

Answer: The ability to clean graffiti from the surface will, to some extent, depend on the finish texture. A rough texture will be difficult to coat successfully with a sealer or paint. Commercially available anti-graffiti paints have been used very successfully on shotcrete tanks with relatively smooth float finishes. We do not have any recommendations on the brand of sealer or coating.

Question: In placing shotcrete in layers, what is the recommended thickness of each layer?

Answer: Appropriate thickness of the shotcrete layers is impossible to generalize because it depends on many factors, including:

1. The type of shotcrete (wet- or dry-mix);
2. The texture and stiffness of the receiving surface;
3. The physical properties of the fresh concrete used, including a) *w/cm* ratio; b) slump; c) use of accelerator; d) type of supplementary cementitious materials used in the mixture (microsilica, fly ash, and slag); e) fibers used in the mixture; and f) mixture temperature;
4. Weather conditions—Is it hot or cold, dry or wet, and/or windy or calm?;
5. The shotcrete equipment used: a) type of nozzle; b) distance from the receiving surface; and c) air pressure and air volume; and
6. The orientation of the shotcreting (vertical/sloped/overhead).

Experienced shotcrete contracting firms using ACI Certified Nozzlemen have a wealth of experience in evaluating all these factors to achieve the proper results. You may consider subcontracting the shotcrete work to an ASA member contractor with experience in this type of work. You can submit your project details for bids from our ASA Corporate Members using the Web form at **http://shotcrete.org/ProjectBidRequest.aspx**.

For further reference, ACI 506R-05, "Guide to Shotcrete," provides some general discussion of the shooting techniques that may be appropriate. Retaining an engineer or shotcrete consultant experienced in shotcrete application may be of value to assist in evaluating your specific factors and recommend the best solution.

Question: Can shotcrete be recycled?

Answer: Shotcrete is concrete applied using the shotcrete process. Therefore, any recycling potential that applies to concrete would apply to shotcrete.

Question: We will be shotcreting the inside of a tunnel entrance. The plan is to apply 3 ft (0.9 m) of shotcrete on the walls and ceiling to support a large section of limestone rock 22 ft (6.7 m) high, 30 ft (9.1 m) wide, and 20 ft (6.1 m) deep above the tunnel at the entrance that has moved and is wedged and supported with an existing steel structure. We would like to test the shotcrete and are wondering what type and quantity of tests you recommend and which testing labs are in our area that would be able to conduct the testing?

Answer: The article "Shotcrete Testing—Who, Why, When, and How" in ASA's Summer 2011 issue of *Shotcrete* magazine should help answer most of your questions on testing of shotcrete. ACI 506R, "Guide to Shotcrete," and ACI 506.2, "Specification for Shotcrete," also have helpful information on shotcrete testing. Most competent testing labs should be able to test the compressive strength of cores extracted from shotcrete panels or sections, as they are very similar to concrete cylinder tests. If conducting more advanced testing, you may want to consider selecting a lab experienced with shotcrete.

Question: We are building 6 and 8 in. (150 and 200 mm) thick cast-in-place concrete retaining walls with No. 4 (No. 13M) reinforcing bar at 18 in. (450 mm) on center each way. We would like to change to shotcrete as an alternate method of construction. Does the reinforcing bar design have to change for shotcrete application?

Answer: Shotcrete would be a great substitute for the retaining wall. Design-wise, the shotcrete is equivalent to concrete because shotcrete is really just a way of placing concrete.

The No. 4 (No. 13M) at 18 in. (450 mm) on-center spacing is not a problem. A No. 4 (No. 13M) bar can be easily encased by a qualified, experienced nozzlemen using either wet- or dry-mix shotcrete. In longer walls, or anywhere where reinforcing bars are lap spliced, the lap splice bars should be spaced apart. ACI 506R-05, "Guide to Shotcrete," Section 5.4, provides some good guidance on optimizing reinforcing bar layouts for shotcreting. On the issue of lap splices, it says: "If the design allows, direct contact of the reinforcing splices should be avoided. Non-contact lapped bars should have a minimum spacing of at least three times the diameter of the largest bar at the splice."

Thus, with No. 4 (No. 13M) bars in a lap splice, you should have the reinforcing bars spaced 1.5 in. (38 mm) apart at the splice to allow the shotcrete material to flow around the bar during shooting.

Chapter 8 of ACI 506R-05, "Guide to Shotcrete," also provides a lot of guidance on proper shooting techniques for a variety of applications, including walls.

Question: I have a question regarding the oscillator on a shotcrete rig. When applying shotcrete, does the oscillator serve any purpose other than uniform application? I'm searching for the main reason to use an oscillator and am wondering if the integrity of the shotcrete would be compromised if it were disabled?

Answer: Assuming this is an oscillator on a robotic arm, it should not be disabled. Good nozzling technique, for either wet or dry, requires the nozzle to be moved in a constant overlapping circular pattern. This allows for better encapsulation of reinforcing bar and produces a more uniform surface; and, particularly for dry process, it is required for final mixing of materials that occurs on the surface.

Without proper nozzle technique, which requires oscillation, you will not get uniform, homogeneous shotcrete.

Question: We will be blasting close to a shotcrete wall. Can you suggest any precautionary measures or offer lessons learned when blasting next to a recently shotcrete wall?

Answer: It is very common in drill and blast operations to blast shortly after the application of shotcrete. There are certainly risks involved, but a knowledgeable and experienced mining crew working with or for a knowledgeable, experienced contractor would not have any problem with this type of application.

A knowledgeable contractor will develop a mixture and procedures to ensure that the timing of the subsequent blast is compatible with the set time of the shotcrete. Preconstruction testing should be required to establish the set time (both early and final set) to assist in developing the sequence of operations. The set time will also be impacted by the site conditions, such as temperature.

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.*

New ASA Members

CORPORATE MEMBERS

Carolina Pool Plastering Inc.
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Castine, ME

James J. Porter
Lufkin, TX

Marcelo Alejandro Sproviero
Geoconcret Servicos de Construcao Ltda
Valinhos, São Paulo, Brazil

Alexander "Sash" Williams
Williams Associates Engineering
Santa Rosa, CA

PUBLIC AUTHORITIES & AGENCIES

Ron Coens
City of New Haven, Engineering
New Haven, CT

John O'Keefe
NYS Dept. of Transportation, Region 7 Operations
Peru, NY

Ray Stoever
State of NJ, Dept. of Community Affairs,
Codes & Standards, LCE
Atlantic Highlands, NJ

Robert Wahlin
Metropolitan Water Reclamation District
of Greater Chicago
Chicago, IL

Michael M. Yeosock
City of Norwalk, CT DPW
White Plains, NY

New ASA Members

STUDENTS

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Cal State Northridge
Pacoima, CA

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Tanta, Gharbia, Egypt

Brice Johnson
U.S. Dept. of Veterans Affairs
Highland, IN

Fatih Kaya
Suleyman Demirel University
Isparta, Turkey

Veronika Kurazhova
St. Petersburg, Russia

Zachary Lewis
Georgia Tech
Sylvania, GA

Luis Manuel Pinillos Lorenzana
Universidad Politécnica de Madrid
Madrid, Spain

Behdad Mofarej
Sharif University of Technology, Tehran
Tehran, Iran

Thanh Nguyen
Loughborough University
Loughborough, Leics, UK

Craig Oxford
UNAM
Grandview, WA

Varun Chowdary Patibandla
Bradley University
Peoria, IL

Ahmed Shinawy
German University in Cairo
Cairo, Egypt

Mohammad Reza Zarrinpour
Arlington, TX

INTERESTED IN BECOMING A MEMBER OF ASA?
Read about the benefits of being a member of ASA on page 70 and find a Membership Application on page 71.

ASA Membership Benefits

	Corporate	Corporate - *Additional Individual*	Individual	Nozzleman	Employees of Public Authorities / Agencies	Student
Annual Dues	$750	$100	$250	$50	Free	Free
Company & specialty information listed in ASA's online Buyers Guide & 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 & Electronic Copies)	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

AMERICAN SHOTCRETE ASSOCIATION

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MEMBERSHIP APPLICATION

Name ______________________________ Title ______________________________

Company ______________________________ Sponsor (if applicable) ______________________________

Address ____

City / State or Province / Zip or Postal Code ______________________________

Country ____________________ Phone ____________________ Fax ____________________

E-mail ______________________________ Web site ______________________________

Please indicate your category of membership:

- ❑ Corporate $750
- ❑ Individual $250
- ❑ Additional Individual from Corporate Member $100
- ❑ Employees of Public Authorities and Agencies Free
- ❑ Nozzleman $50
- ❑ Retired $50 (For individuals 65 years or older)
- ❑ Student Free (Requires copy of Student ID card or other proof of student status)

NOTE: Dues are not deductible as charitable contributions for tax purposes, but may be deductible as a business expense.

Payment Method:

❑ MC   ❑ Visa   ❑ Check enclosed (U.S. $)

Card# ______________________________ Expiration date ____________________

Name on card ______________________________ Signature ______________________________

Company Specialties—Corporate Members Only

Company Specialties are searchable in the printed and online Buyers Guide.

Admixtures
- ❑ Accelerating
- ❑ Air Entraining
- ❑ Foaming
- ❑ Retarding
- ❑ Shrinkage Compensating
- ❑ Special Application
- ❑ Stabilizing
- ❑ Water Proofing
- ❑ Water Reducing-Accelerate
- ❑ Water Reducing-High Range
- ❑ Water Reducing-Mid Range
- ❑ Water Reducing-Normal
- ❑ Water Reducing-Retarding
- ❑ Water Repellent

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

Consulting
- ❑ Design
- ❑ Engineering
- ❑ Forensic/Troubleshooting
- ❑ Project Management
- ❑ Quality Control Inspection/Testing
- ❑ Research/Development
- ❑ Shotcrete/Gunite
- ❑ Skateparks

Contractors
- ❑ Architectural
- ❑ Canal Lining
- ❑ Culvert/Pipe Lining
- ❑ Dams/Bridges
- ❑ Domes
- ❑ Flood Control/Drainage
- ❑ Foundations
- ❑ Grouting
- ❑ Lagoons
- ❑ Mining/Underground
- ❑ Parking Structures
- ❑ Pumping Services
- ❑ Refractory
- ❑ Repair/Rehabilitation
- ❑ Residential

Contractors, contd.
- ❑ Rock Bolts
- ❑ Rock Carving
- ❑ Seismic Retrofit
- ❑ Sewers
- ❑ Skateparks
- ❑ Slope Protection/Stabilization
- ❑ Soil Nailing
- ❑ Storage Tanks
- ❑ Structural
- ❑ Swimming Pools/Spas
- ❑ Tunnels
- ❑ Walls
- ❑ Water Features

Equipment
- ❑ Accessories
- ❑ Adaptors
- ❑ Air Vibrators
- ❑ Bowls
- ❑ Clamps
- ❑ Compressors
- ❑ Couplings
- ❑ Feeder/Dosing
- ❑ Finishing
- ❑ Grouting

Equipment, contd.
- ❑ Guide Wires
- ❑ Gunning Machines
- ❑ Hoses
- ❑ Mixers
- ❑ Nozzles
- ❑ Pipe/Elbows/Reducers
- ❑ Plastering
- ❑ Pre-Dampers
- ❑ Pumps
- ❑ Robotic
- ❑ Safety/Protection
- ❑ Silo Systems
- ❑ Valves
- ❑ Wear Plates

Fibers
- ❑ Carbon
- ❑ Glass
- ❑ Steel
- ❑ Synthetic

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

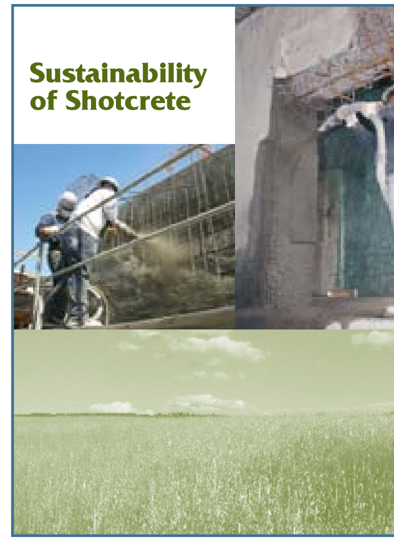
Sustainability of Shotcrete

Sustainability continues to grow as a driving force in the decision making of Owners and Specifiers regarding construction materials and placement strategies. "Sustainability of Shotcrete" is a timely and valuable resource to promote the shotcrete process and educate potential clients and owners. The document can also be submitted with project bids to identify and substantiate the sustainability advantages of the shotcrete process.

This 10-page, full-color brochure identifies and discusses the numerous shotcrete sustainability advantages and also includes case studies demonstrating these advantages in both new construction and repair.

The brochure's content was originally developed by the ASA Sustainability Committee for use in the United States Green Concrete Council (USGCC) book titled *The Sustainable Concrete Guide—Applications*. The full book can be ordered from **www.concrete.org**.

Copies of "Sustainability of Shotcrete" can be ordered from the ASA Web site at **www.shotcrete.org** or by calling 248-848-3780. For orders outside of North America, please contact ASA directly.



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Take a picture! Take several! From beginning to end, photos add a lot to the story. If you have high quality/print resolution photos to support the work you do, you could enter your project for ASA's Outstanding Shotcrete Projects Award Program.

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http://shotcrete.org/ASAOutstandingProjects.htm

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