Shotcrete MAGAZINE

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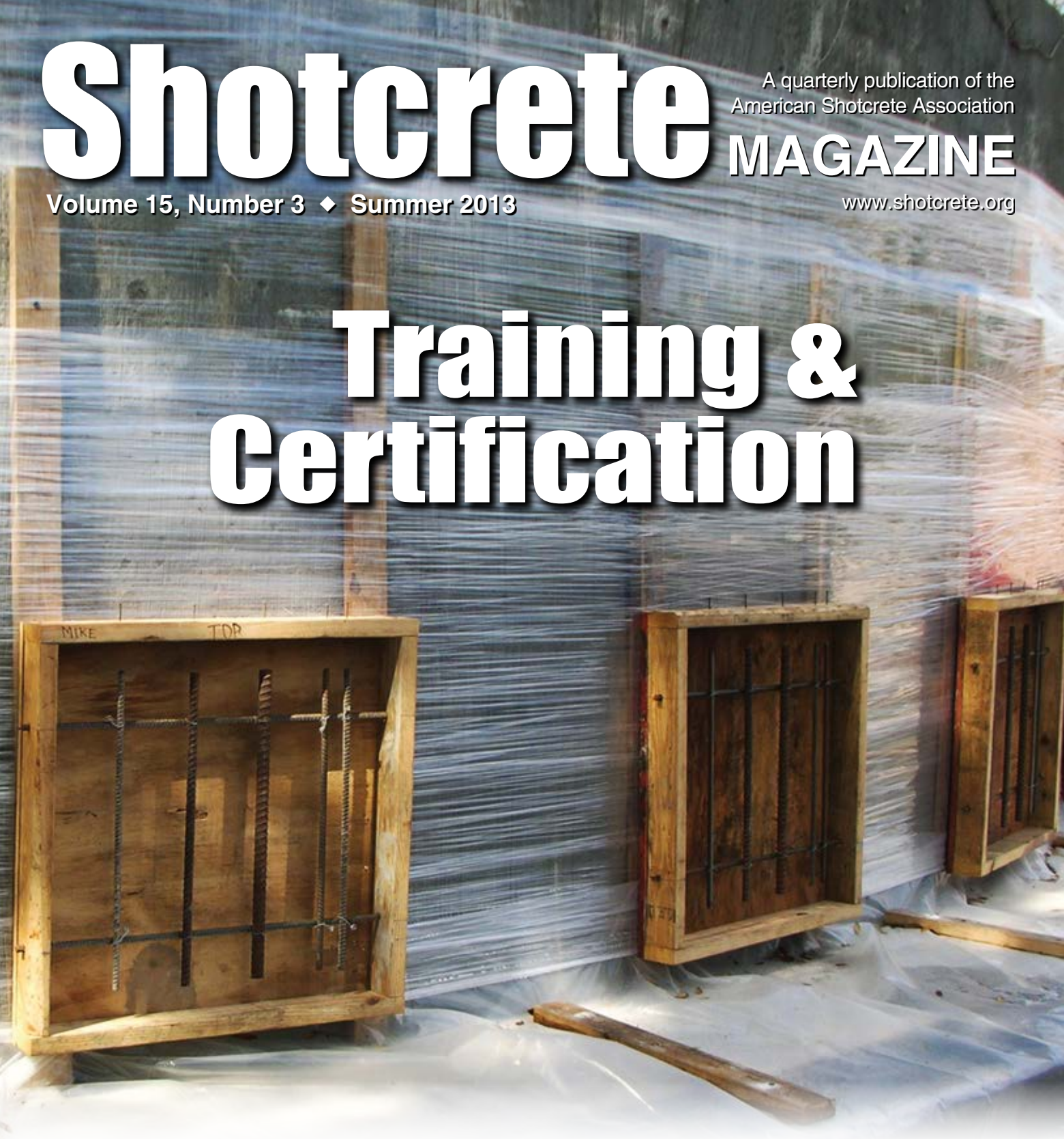
www.shotcrete.org

Training & Certification



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Shotcrete MAGAZINE
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Features

Departments

On the cover: Panels prepared for a certification session at The Crom Corporation, Gainsville, FL.
Photo courtesy of Marc Jolin, Laval University

Training and Certification: The Unintended Consequence

The Vision of Shotcrete Certification Versus the Reality

By Michael P. Cotter

"The American Shotcrete Association (ASA) was founded in 1998 'to have the shotcrete process understood and used in every beneficial application' (the Vision Statement) and 'to encourage and promote the safe and beneficial use of the shotcrete process.' (the Mission Statement)

With this in mind, the discussion over the importance of shotcrete nozzleman certification at the time, and the vehicle by which a certification program could be delivered, was debated by industry members everywhere, and led to one of ASA's first industry tasks. A shotcrete nozzleman certification program was developed by ASA…"
(from *Shotcrete* magazine, Winter 2008, "Shotcrete Nozzlemen: ASA Trains—ACI Certifies," by Jean-François Dufour)

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

An "unintended consequence" of developing this certification program seems to be that the ACI Nozzleman Certification requirement is sometimes replacing **experience** in project specifications. A few years ago when I spoke to a designer about this he said, "Mike, we don't need experienced contractors—our new specification calls for an ACI Certified Nozzleman. That's all we need."

I ask you, ASA members: Does this seem right? I ask material suppliers, contractors, engineers, designers, and equipment suppliers: Do you think this is right?

Shotcreting is hard work. I decided to become a better nozzleman more than 38 years ago when I got sick of shoveling rebound from overhead shotcrete placement. I truly believe that there are no shortcuts! Shotcreting has, and always will be, **a team effort**—from the gun man, rod man, and layout wireman to the finisher, hose dragger, and nozzleman.

You can help the industry gain a better understanding of current trends. Please dig up your different specifications and send them to ASA.

On a different note, we're pleased to be working with the ASA Board to create the position of Technical Director. The following are some goals ASA would like the Technical Director to pursue:

- Expand awareness of proper shotcrete practices;
- Increase support to ASA members as a technical resource;
- Assist with the implementation of an apprentice nozzleman and inspector training program by ASA;
- Assist with the development and implementation of a contractors qualification program by ASA;
- Reinforce the need to recertify nozzlemen who have left their sponsors' employment; and
- Help promote the inclusion of ASA-affiliated programs in specifications.

Also, ASA will be meeting October 19, 2013, at the ACI Fall Convention in Phoenix, AZ. Please take the time to attend and participate. Our industry needs to stick together. You can refer to the schedule in this issue's Association News or at **www.shotcrete.org/pages/news-events/calendar.htm**.

Finally, all of us at ASA would like to send our deepest condolences to the families of Pete Tatnall, former President of ASA, and Ed Brady, ASA Director. Both of these gentlemen contributed greatly to the success of the ASA and both will be missed. ASA has a page dedicated to each of them in this edition of *Shotcrete* magazine.

Ironically, repairing one of the busiest tunnels in Steel City required our shotcrete.

When Pittsburgh's 80-year-old Liberty Tunnels needed structural repairs, QUIKRETE® Shotcrete MS got the job done. Crews were able to complete their work within tight time constraints using the dry process with a pre-dampener. In fact, our shotcrete products were part of the American Shotcrete Association's "Outstanding Underground Project" for 2009, 2010 and 2012.

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ASA Publications Committee

By Ted Sofis

I would be remiss if I didn't take a moment to say something about two of our ASA members—Pete Tatnall and Ed Brady—who recently passed away. Pete Tatnall was the second President of the American Shotcrete Association (ASA) and Ed Brady was an ASA Board member, an ACI Nozzleman Examiner, and an extremely active participant in several ASA committees. Both men cared deeply for ASA, and I considered them to be not only colleagues but also good friends.

When I first joined ASA, Pete welcomed me into the association and was always positive, encouraging me to become more involved. When I responded to shotcrete-related technical questions in our question forum, he would often take a few moments to e-mail me and let me know that he liked my comments. Pete was a genuinely good guy, who was always glad to share information and help in any way he could. He was the kind of guy who wanted others to become involved.

Ed Brady was the consummate gentleman, and he would always take an extra few minutes to be cordial. You couldn't help but like Ed. He was as sincere and honest as they come. Ed too was highly involved in ASA. He served on our Board of Directors and on several committees. In addition to conducting ACI certification sessions, I worked with Ed on many occasions and our respect for each other was mutual.

Ed Brady and Pete Tatnall contributed greatly to the development and growth of ASA. They will be greatly missed by all of us in the industry.

Committee Chair Memo

I have enjoyed writing for *Shotcrete* magazine, and it has been a pleasure to serve as Chair of the Publications Committee. I appreciate the sharing of information that occurs within the pages of our publications and on the ASA website. I am especially proud of our technical forum, where we answer shotcrete-related technical questions.

The theme of our current issue of *Shotcrete* magazine is "Training and Certification." The theme for the upcoming Fall 2013 issue will be "Shotcrete Materials." Our Winter 2014 issue will again be dedicated to this year's outstanding project award winners.

Last year we moved the Outstanding Shotcrete Project Awards issue from the spring to the winter issue. This was done so that the magazine features on the selected projects would coincide with the awards banquet at World of Concrete in Las Vegas, NV.

We vary our themes to cover different applications, market segments, and a variety of areas where shotcrete is used. We try to provide an open forum and suggestions are always welcome.

As you may have noticed, the ASA website was redesigned to make the site more intuitive. The new website provides improved capabilities to access archived articles and allows the full text of every article to be searched, rather than just the keywords. Therefore, every article in all 14 years of *Shotcrete* magazine that contains a desired word or phrase is accessible online in an easy-to-use format.

Shotcrete magazine is always looking for new authors, particularly nozzlemen or other craftsmen involved in shotcrete, who are interested in suggesting or writing about a topic of interest or one they may be passionate about. It may not be included in the magazine right away, but we welcome ideas and author submissions.

If interested, please forward any suggestions or express your interest at info@shotcrete.org, and we'll be happy to work with you. We want to write about topics that are relevant and of interest to our readers, so your involvement is most welcome!

Shotcrete magazine is a targeted publication that is distributed to ASA members and contractors, engineers, and manufacturers involved in the shotcrete industry. It is also circulated to public agencies, engineering firms, and general contractors. There is a wealth of knowledge on shotcrete within the ASA membership, and the magazine is a resource that the association willingly provides. We want the information in the magazine and the website to be accessible to all of you.

Much of what you see in *Shotcrete* magazine is due to the efforts of our Technical Editor Charles Hanskat and Program Coordinator Alice McComas. I would like to personally thank them both for a job well done.

Let ASA's Corporate Member Benefits Work for You

By Mark A. Campo, ASA Executive Director

One of the best decisions you can make on behalf of your organization is to join the American Shotcrete Association (ASA) as a Corporate Member. Corporate Members comprise a significant percentage of ASA's overall makeup; and as a sign of appreciation, ASA offers some significant membership benefits tailored just for them.

Some of the benefits of joining ASA include being listed in the "Buyers Guide," as well as discounts on publications, certification, advertising, and complimentary brochures. But I'd like to take this opportunity to remind you of some additional, lesser-known but highly valuable, benefits that ASA extends to its Corporate Members at no charge.

Marketing via www.whyshotcrete.org

A new addition to ASA's overall web presence is a page titled "Why Shotcrete?"—which is accessible directly at **www.whyshotcrete.org**. Intended to be ASA's frontline marketing tool to promote the use of shotcrete in all beneficial applications, this page highlights the features and benefits of shotcrete that make it the preferred placement method for numerous applications.

ASA encourages you to refer and/or link to this web page as a resource in your own marketing efforts to reinforce the idea that properly placed shotcrete offers a competitive advantage over other concrete placement methods in many instances.

Whether you're a designer or specifier researching the best construction method for your project or a contractor new to shotcrete who wishes to learn more about the process and its versatility, this page provides an overview of the substantial time and cost savings, sustainability benefits, and real-world examples of when and where to use shotcrete.

New Products & Processes

Are you offering a new service that the entire shotcrete industry needs to know about? Releasing a new line of equipment or materials? Promoting a new time and money-saving process? This regular feature in *Shotcrete* magazine provides an opportunity to showcase your company's latest offerings—directly capturing the attention of the shotcrete industry—in the only publication dedicated specifically to promoting quality shotcrete.

As a benefit to its Corporate Members, ASA welcomes the chance to hear about your latest products and services. Be sure to send your latest press release to info@shotcrete.org.

Industry News

Yet another opportunity for ASA's Corporate Members to spread the word on their company's latest developments is the Industry News feature of *Shotcrete* magazine. This feature is a dedicated showcase for corporate developments, milestones, or product awards. Regularly featured items here often include the opening of new plants or supply channels, corporate anniversaries, or industry partnerships.

The Industry Personnel segment within this feature is also a great way to shine a spotlight on industry leaders celebrating personnel awards and accolades, notable achievements, or noteworthy appointments. If you are proud of your workforce and wish to recognize their individual achievements, ASA gives you a platform to do so.

Corporate Member Profile

ASA's Corporate Member Profile is the final lesser-known yet extremely valuable Corporate Member benefit that I'd like to point out. In each issue of *Shotcrete* magazine, ASA offers a featured profile of one of its Corporate Members. With significantly more visibility than a news item or update, this feature provides up to two full pages of visibility specifically dedicated to your organization—amounting essentially to free full-page listings of your company's specialized services, photos, and contact information.

Pick up your latest copy of *Shotcrete* magazine and check out who's featured in this issue's Corporate Member Profile—perhaps the next issue could feature your company.

To submit information for any of the above *Shotcrete* magazine promotional opportunities, simply e-mail us at info@shotcrete.org. For more contact details, please visit **www.shotcrete.org/pages/membership/contact.htm**.

Not an ASA member? We can help you there as well, and we welcome you to participate alongside the many others who promote the proper placement of quality shotcrete by well-educated and qualified individuals. Visit **www.shotcrete.org/membership/index.htm**.

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In Memoriam

Peter C. Tatnall
September 20, 1938–April 26, 2013

Pete Tatnall was born in Worcester, MA. He received a degree in civil engineering from Rensselaer Polytechnic Institute (RPI) in 1962; and after serving as a First Lieutenant in the U.S. Army Corps of Engineers, he began a career that would lead to his very unique insight into and thorough knowledge of the material we know as concrete. Beginning with Lehigh Portland Cement Co. in 1965, he moved from Operations Manager in cement to the concrete division to ready mixed precast concrete and, finally, into aggregate production, which collectively gave him experience with all the components and uses of concrete. In 1979, Pete joined Bekaert Corporation, where he harnessed his cement and concrete knowledge to manage and develop the use of steel fiber for reinforcement of concrete. Two years later, he moved to Novocon International, where he continued to work with steel fiber-reinforcement technology until his retirement.

Pete's thorough understanding of concrete and keen engineering mind provided him with the ability to design and adapt concrete technology, steel reinforcement, and field experiences for the purpose of improving standards and guidelines, as well as to educate the industry. His contributions to the American Concrete Institute (ACI) through committee work and Task Group documents were recognized by naming him an ACI Fellow in 1999. Pete chaired several committees until retirement and served as a Consulting and Voting member of ACI Committees 302, Construction of Concrete Floors; 360, Design of Slabs on Ground; 506, Shotcreting, as well as several 506 Task Groups; and 544, Fiber-Reinforced Concrete.

Pete joined ASTM International in 1983 and was instrumental in developing standards in both steel fiber-reinforced concrete and shotcrete. He served as Chair of ASTM Committee C09.42, Fiber-Reinforced Concrete, and Subcommittee C09.46, Shotcrete, from 1990 to 2001 and 2001 to 2008, respectively. Pete worked with ASTM Committee A01 to help write ASTM A820, "Standard Specification for Steel Fibers for Fiber-Reinforced Concrete." He was active as a member of Committees A01, Steel, Stainless Steel and Related Alloys; C09, Concrete and Concrete Aggregates; and C27, Precast Concrete Products.

The American Shotcrete Association (ASA) began with discussions by a few industry activists—Pete among them—in the mid-1990s. His dedication to the founding and development of an organization that would improve and expand the use of shotcrete as a method of placing concrete was an important factor in ASA's birth and growth. Pete served as a Board member; Treasurer; and, in 2000, as President. His penchant for detail and order, practiced so well in his life and service, inspired his successors and contributed to the success of ASA. All who served and worked with Pete are better for the experience.

Pete's work lives on in several ASTM standards and ACI guidelines from the committees he led and served. His contributions and guidance to develop a better understanding of steel fiber-reinforced concrete and shotcrete are clearly recorded in committee annals and in many technical publications authored by him. Unrecorded, though well-known by his colleagues and associates, was his tireless support and patient teaching of concrete science to solve problems and improve our industry.

Pete lived in the Atlanta, GA, area since 1979 and retired there with his wife Mary Lou. He is also survived by three (adult) children: Lori Tucker, Lynn Ralph, and Leah Dennis. His dedication and service to the industry and to ASA were profound. ACI Fellow, founding member and past President of ASA, tireless advocate for the technology of concrete and shotcrete, great friend, mentor and advisor to many, Pete will be missed but not forgotten.

Mary Lou and Pete Tatnall at an annual high school reunion held in the Finger Lakes area. Eight graduates from KWHS met at Keuka Lake for over 35 years—all were engineers encouraged to pursue an engineering career by their Kenmore teachers

Donations in Pete's memory can be made to the Kenmore High Scholarship Fund—a fund designed to aide students in pursuit of a career in engineering with continued studies at an engineering college/university:

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In Memoriam

Patrick Bridger (left) and Joe Hutter (center) present Ed Brady (right) with the 2011 ASA Outstanding Shotcrete Project Award in Underground Shotcrete

Leah and Ed Brady

William Edwin Brady died tragically at the age of 55 on May 30, 2013, leaving us shocked and heartbroken. We in the industry knew Ed as the owner of Edwin Brady Construction, a company specializing in grouting and concrete repair. We also knew him as a civil engineer (licensed in Kentucky and Colorado); an ACI Certified Shotcrete Nozzleman and Examiner; a member of ACI Committees 506, Shotcreting, and C660, Shotcrete Nozzleman Certification; and as a member of the Board of ASA. In his professional career, Ed was awarded the 2000 ABC Excellence Award for historic restoration of a railway tunnel. In 2011, his work was recognized with the ASA Outstanding Shotcrete Project Award in Underground Shotcrete.

Ed was an extremely active member and constant contributor to various ACI and ASA committees. Recently, Ed was appointed Co-Chair of the ASA Education Committee; and he was near completion of a completely new education module that was to combine current educational material from ACI CP-60, current construction practices, and recent developments in the industry. Due to Ed's engineering background and direct hands-on experience, his vision was to create training material that provided the required knowledge, presented from the worker's perspective. In recent years, Ed had written several technical articles on shotcrete placement, which were published in *World Tunnelling* and *Shotcrete* magazine. Ed's willingness to share his deep technical knowledge of shotcrete and grouting was of great value to the construction industry.

But the construction industry was only part of what Ed did. He was also a farmer. As a registered breeder of Black Angus cattle, he owned and operated Brady Leah Farm. Ed was a member of Lodge #2 Free and Accepted Masons and had obtained the degree of Master Mason. He was also a member and Past President of the Rotary Club and Troop Master of Boy Scout Troop #276, having been an Eagle Scout himself. Ed was a man of strong faith and a very active member of his church, giving a lot of his time to helping people in need.

Ed was born and lived in Paris, KY, with his wife Leah and their three children (triplets) still at home, Robert (Bob), James (JEB), and Laura (Lala). Ed would say how fortunate he was that he could attend a high school football game and watch Bob play on the team, JEB in the school band, and Lala as a cheerleader. He also leaves behind two step-children, Leslie Lundy and David Houston Jr.; two grandchildren, Savanna and Joel Lundy; a sister, Stephanie Ed; two nieces; and his parents, James and Jane Brady, all of Paris, KY.

He was generally a very humble, quiet man, always listening to people; so when he did speak, it was always something worth listening to. His work in both ASA and ACI was always meticulous and precise; he was an outstanding engineer and his contributions were unique and very often effective. Ed wore many hats and was many things to many different people; but, most of all, he was a very nice and good man. As with many others, we feel fortunate to have known him and will really miss his camaraderie at ASA events. Our industry has lost a strong, determined member and he will be missed by all.

Obituary and an opportunity to send condolences to the family can be found at:
http://www.hinton-turnerfuneralhome.com/index.php?P=32&FILENUMBER=735&ObituaryId=735.
Memorials are suggested to Bedford Acres Christian Church, www.bedfordacres.com.

ANNOUNCING THE 2013-2014 American Shotcrete Association Graduate Scholarship PROGRAM

The purpose of the **ASA Graduate Scholarship Program** is to attract, identify, and assist outstanding graduate students pursuing careers within the field of concrete with a significant interest in the shotcrete process.

Two $3000 (USD) awards are available for the 2013-2014 academic year. One scholarship will be awarded to a graduate student within the United States and the second scholarship will be awarded to a graduate student in Canada.

All applications and required documents must be received by **5:00 p.m. EDT** on **Friday, November 1, 2013**.

Obtain an application and requirements at: **www.shotcrete.org/ASAscholarships**.

AMERICAN SHOTCRETE ASSOCIATION

ASA welcomes all students to take advantage of the outstanding benefits of a free Student Membership with both ASA and the American Concrete Institute (ACI).

You can find more information and sign up as an ASA Student Member at: **www.shotcrete.org/membership**

You can find more information and sign up as an ACI Student Member at: **www.concrete.org/students/stu.htm**

*The original version of this article was written by Jean-François Dufour and published in 2008 (*Shotcrete *magazine, V. 10, No. 1). It has been revised and updated by Marc Jolin and Randle Emmrich to reflect the most current certification information.*

Shotcrete Nozzlemen: ASA Educates—ACI Certifies

By Jean-François Dufour, Marc Jolin, and Randle Emmrich

How do we distinguish the role of the American Shotcrete Association (ASA) and the American Concrete Institute (ACI) when it comes to *shotcrete nozzleman certification*? The answer lies in the title of this article. ASA educates whereas ACI certifies!

As with any other ACI certification program, examination sessions are conducted by local sponsoring groups (LSGs). Although most ACI certification programs are typically administered by local ACI chapters approved as LSGs, Shotcrete Nozzleman Certification programs require a higher degree of logistics, exceeding most ACI chapter resources. Arguably, the Shotcrete Nozzleman Certification program is the most demanding certification program available through ACI. Both physically and logistically, the program requires strong commitments from well-established LSGs. ASA's contribution as the first ACI LSG for nozzleman certification was instrumental to fully developing this ACI certification program[1,2] and continues to contribute to its success, with over 1300 certificates currently valid. This article provides an overview of shotcrete nozzleman education and certification in North America with the most current updates from activities of both ASA and ACI committees.

American Shotcrete Association (ASA)

The American Shotcrete Association was founded in 1998 "to have the shotcrete process understood and used in every beneficial application" and "to encourage and promote the safe and beneficial use of the shotcrete process."

With this in mind, the discussion over the importance of shotcrete nozzleman certification at the time, and the vehicle by which a certification program could be delivered, was debated by industry members everywhere and led to one of ASA's first industry tasks. A shotcrete nozzleman certification program was put together by ASA with the hope that ACI would fast track the completion of the ACI shotcrete nozzleman certification program as part of its certification activities.

Members of ASA worked diligently to complete the development of the Shotcrete Nozzleman Certification program and launched the first shotcrete Training and Certification Session in 1999. This session also served to qualify future trainers and examiners and helped define what eventually became two separate entities: ASA's Education Program and the ACI Shotcrete Nozzleman Certification program.

ASA was the first LSG to administer the ACI written and performance examination starting in 2001 and has been actively promoting the program and certifying nozzlemen since that first session. ASA also provides a Shotcrete Education Session (classroom only) for nozzlemen taking the ACI Certification Examination and for those simply interested in learning correct nozzleman techniques (for example, owners, project supervisors, and foremen).

ASA's Shotcrete Nozzleman Education

The ASA Education Committee developed a series of Shotcrete Education Modules covering the key aspects necessary for successful shotcrete application. ASA's education modules are under continuous review and revision to update current construction practices and technology. The Education Module presentations are supplemented in the classroom with ACI CP-60(09), "Workbook for ACI Certification of Shotcrete Nozzlemen."[3] ACI CP-60 was developed and is maintained by ACI Committee C660, Shotcrete Nozzleman Certification, to provide reference study material for nozzleman certification candidates. The ASA Education Modules cover the full range of concrete/shotcrete-related technical material, including:

- Introduction to Shotcrete;
- History and Uses of Shotcrete;
- Shotcrete Materials and Properties;
- Shotcrete Mixture Designs;
- Quality Control/Quality Assurance;

- Shotcrete Equipment;
- Preparation for Shotcreting;
- Shotcrete Nozzling and Application Techniques;
- Shotcrete Finishing and Curing Procedures; and
- Safety.

ASA Education Sessions are conducted by ACI Examiners for Shotcrete Nozzlemen, who are approved and appointed by the ASA Board of Direction. This mandatory course for all new candidates seeking ACI Shotcrete Nozzleman Certification through ASA not only provides an excellent foundation to succeed on the written portion of the certification exam but also an excellent resource for all those who need to work with shotcrete in any capacity. The ASA Education Sessions have been offered in recent years at major trade shows such as World of Concrete and the Pool | Spa | Patio Expo. Participation in these sessions fulfills the ASA education requirement while providing valuable information to help you become a better nozzleman. Please see ASA's calendar for this year's courses: http://shotcrete.org/pages/news-events/calendar.htm.

Apart from ASA, there are currently only a handful of ACI-approved LSGs that offer ACI Shotcrete Nozzleman Certification. Information on these LSGs is available on the ACI website. The ACI Shotcrete Nozzleman Certification program has been operating successfully for the last 12 years. The program continues to gain recognition among federal, state, provincial, and private specifying authorities throughout North America. Adding to the popularity of specifying ACI nozzleman certification on shotcrete projects is the fact that there are now over 1300 ACI-certified shotcrete nozzlemen in North America.

ACI's Shotcrete Nozzleman Certification Program

For decades, the shotcrete industry has recognized the need for more stringent standards when it comes to shotcrete quality. In addition to good-quality, well-proportioned shotcrete mixtures, suitable well-maintained equipment, and an experienced shotcrete construction team, a qualified shotcrete nozzleman is a key element to successful shotcrete placement. ACI Committee C660 has delivered a credible and thorough program with strict policies, guidelines, and procedures that respond to the demands of the construction industry.

A select group of experienced and acknowledged shotcrete experts has been approved by ACI to act as Examiners for the certification program (refer to Examiner Requirements and Approval Process in the following). Today, certification of a shotcrete nozzleman through this ACI program provides nozzlemen with not only improved knowledge and skills but also with international recognition as a craftsman.

Although no certification program can address all potential variables, the ACI Shotcrete Nozzleman Certification program is focused on specific key elements of the shotcrete process such as knowledge, skill, and ability. The ACI Certification Program requires a prerequisite of 500 hours of verified work experience as a nozzleman to attend the certification session.

In addition, to achieve certification from the ACI program, candidates must fulfill the following requirements[4]:

- Achieve a passing grade in the 90-minute written examination per process; and
- Successfully complete the following two-part performance evaluation:
  - Part I—Demonstrate knowledge of all the items covered in the performance checklist; and
  - Part II—Shoot a test panel with the method(s) and position(s) to be certified. The test panels are cored in five predetermined locations (through embedded reinforcing bars); these cores are evaluated as specified in the policies.

Note: Without the mandatory shotcrete education session ASA provides when they conduct ACI Shotcrete Nozzleman Certification, many nozzlemen would find these requirements difficult to achieve.

The certification program is available for both the dry- and wet-mix shotcrete processes and two shooting positions: vertical and overhead. All nozzlemen must qualify in the vertical shooting orientation and may elect to qualify in the overhead shooting orientation in either the dry- or wet-mix shotcrete process, or both. The ACI Shotcrete Nozzleman Certification is valid for a period of 5 years from the date of completion of all certification requirements.

Considering the difficulty in some areas for a nozzleman to acquire the 500-hour minimum experience prior to attending the certification session, ACI Committee C660 has been actively working on the concept of a "nozzleman-in-training." A nozzleman-in-training would be allowed to gain experience hours while working under the direct supervision of an ACI-certified nozzleman at the job site. The formal procedures for acquiring a nozzleman-in-training level certification are still under development by ACI Committee C660; visit the ACI website for the most up-to-date policies in the upcoming months (www.concrete.org/certification/cert_ProgramPolicies.htm).

ACI's Certification Policies for Shotcrete Nozzlemen

ACI Committee C660's original mandate was to develop, maintain, and update programs for use in certification of persons performing as shotcrete nozzlemen. As the certification program grows, the program policies are continually updated to maintain the integrity of the program.

ACI Recertification Policy

One of the committee's objectives in maintaining the integrity of the program was to provide an incentive to contractors to recertify before certification expires. To avoid duplicating the expense of the original shotcrete certification program, the policies were updated to allow the shotcrete contractor to have recertification conducted without mandatory ASA training and related incidentals, such as the written examination. These changes were introduced as follows.

A candidate may renew certification (recertify) by successfully completing:

1. A structured oral interview with the Examiner.

   The interview is in lieu of the written exam requirement imposed for initial certification and is designed to substantiate that the candidates have retained their knowledge of the safe and competent application of shotcrete and are made aware of any new developments in this area of concrete construction; and
2. A performance examination as per the current policies.

   This recertification policy is available for those who are seeking recertification in the same process within 6 years of their previous ACI-issued certification. Nozzlemen must possess at least 1000 hours of work experience as a shotcrete nozzleman within the 2 years immediately prior to seeking recertification or possess an average of 500 hours per year of shotcrete nozzleman experience within the 5 years immediately prior to seeking recertification.

   Most recertification sessions have been conducted at job sites where ACI examiners were able to travel to conduct recertification rather than asking a group of nozzlemen to travel to a single location. This has enabled recertification costs to be kept to a minimum.

ACI Examiner Requirements—Approval Process Policy

As the certification program grows, the need for more ACI-approved Examiners increases. Also, the program must be readily accessible to shotcrete nozzlemen throughout North America.

According to the recent updated policy, an Examiner must be approved for dry- and/or wet-mix shotcrete with the assistance of a task group under the direction of ACI Committee C660. Qualifications must be submitted separately for the dry- and/or the wet-mix processes.

The requirements are described as follows:

- The Examiner shall be authorized by ACI to conduct nozzleman certification examinations for only the shotcrete process for which the Examiner is approved; and
- To be considered for approval as an Examiner and to maintain Examiner status, the applicant shall meet the following requirements:
  - A. Be knowledgeable about shotcrete and thoroughly familiar with the current applicable reference documents; and
  - B. Have a total of at least 5 years of documented experience in at least two of the following four categories:
    1. Testing, inspection, and quality control of shotcrete;
    2. Supervision of shotcrete construction work;
    3. Design of shotcrete structures; and
    4. Shotcrete nozzling.
  - C. Have sufficient experience to evaluate and judge the qualifications of shotcrete nozzleman applicants and conduct written and performance examinations. For each process, this experience must be (but is not limited to):
    - Knowledge of both vertical and overhead spraying; and
    - Knowledge and experience on more than one type of equipment (gun, pump, or nozzle).
  - D. Have participated to the satisfaction of the Examiners of Record in all phases of at least two ACI-sanctioned shotcrete nozzleman certification programs for the process in which approval is sought, with different Examiners of Record for each session. For the first session, the applicant must serve as proctor and Supplemental Examiner. For the second session, the applicant shall serve as a Proctor and Supplemental Examiner and conduct all phases of the session, including written examination; performance examination; and core grading, under the direct supervision of the Examiner of Record for both vertical and overhead;
  - E. Attain a passing grade on the written exam for each process sought; and
  - F. To maintain Examiner status, the Examiner must have conducted or assisted in at least three ACI-sanctioned shotcrete nozzleman certification programs in 5 years, if not actively participating in ACI Committee C660 activities.

Panel Affixation Specification Document

Shotcrete nozzleman certification for overhead shotcrete requires the use of standardized panels that are affixed overhead. ACI Committee C660 was asked to provide a specification document that would include general parameters for an apparatus or structure that would quantify the forces in hanging and shooting a panel to assist and provide guidance with on-site construction. A specification document was developed, accompanied by a sample drawing of a suitable apparatus that is typically used for overhead shotcrete nozzleman certification. The proposed apparatus is illustrated in Fig. 1.

Shotcrete Core Grades—Standard Certification Panel

Core grading shall apply only to cores extracted from the standardized test panel approved by ACI Committee C660. Grading of the cores is based on visual examination and measurements of defects. A total of five cores are graded using these criteria at specific locations.[4,5] Deductions are made for various defects such as (but not limited to) sand lenses; porosity pockets; and random voids, especially voids around reinforcing bars.

A test panel is declared a failure if any single core exceeds core Grade No. 3 or if more than two of the five cores exceed core Grade No. 3. Averaging core grades is not permitted. Definitions of core Grades No. 1 to 5 are provided in the program policy[5], and, more recently, in the new document "Shotcrete Core Grades for Use in the Evaluation of Cores during Shotcrete Nozzleman Certification according to CP60 (09)."[3] Sample photos of core Grades No. 1 and 5 are presented in Fig. 2.

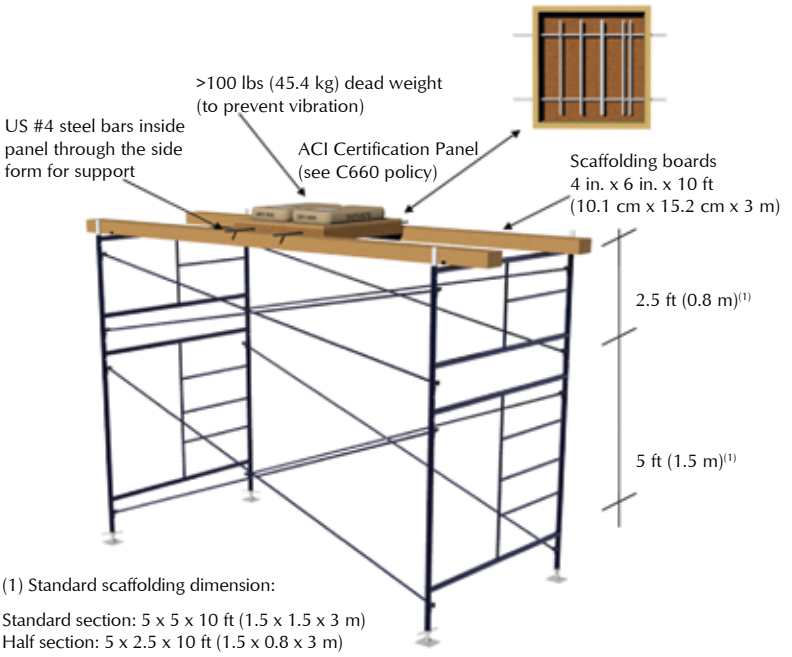

Fig. 1: Overhead standard set-up—ACI Shotcrete Nozzleman Certification

Fig. 2: Core Grades No. 1 and 5

A Message to Shotcrete Specifiers!

ACI Shotcrete Nozzleman Certification makes a difference. Although it does not guarantee perfection, it provides the specifier with the comfort that the nozzleman has demonstrated the basic knowledge and capabilities to properly apply shotcrete. However, the ACI-certified nozzleman is only one part of the shotcrete construction team. A contractor offering to place quality shotcrete must have specific knowledge, equipment, training, and hands-on experience of an entire shotcrete construction team—from company management to the entire field team—to truly be considered a shotcrete contractor. The identification and selection of a qualified shotcrete contractor is essential for quality shotcrete work on your project.

To ensure a quality shotcrete application on specific projects with demanding shotcrete placement (for example, deep sections and multiple layers of reinforcing), preconstruction qualification mockups that simulate job-site conditions may be desirable. To assist design professionals, owners, contractors, and other construction personnel in achieving desired quality, ACI 506R-05, "Guide to Shotcrete,"[6] has procedures for qualifying shotcrete nozzlemen where project requirements have features that dictate more than just ACI nozzleman certification.

Specifier, this ACI Shotcrete Nozzleman Certification program has been developed for you. Take advantage of the tool you have been given and specify ACI-certified shotcrete nozzlemen on your construction projects!

How Do I Get Certified?

To participate in an ACI Shotcrete Nozzleman Certification program, interested parties should first contact ASA. As an LSG, ASA will provide

a candidate with the necessary information on both ASA education and the ACI Shotcrete Nozzleman Certification program. They will then process the inquiry and contact ACI-approved examiners to coordinate the certification program. To request a quote for shotcrete nozzleman certification, go to: https://www.shotcrete.org/pages/secured/CertificationQuote.aspx.

The authors would like to both recognize and thank all ACI Committee C660 members for their dedication to the improvement of shotcrete practices throughout the industry, with special thanks to Merlyn Isaak, who was ACI Committee C660 Chair during the development and launch of the ACI Shotcrete Nozzleman Certification Program in 2001.

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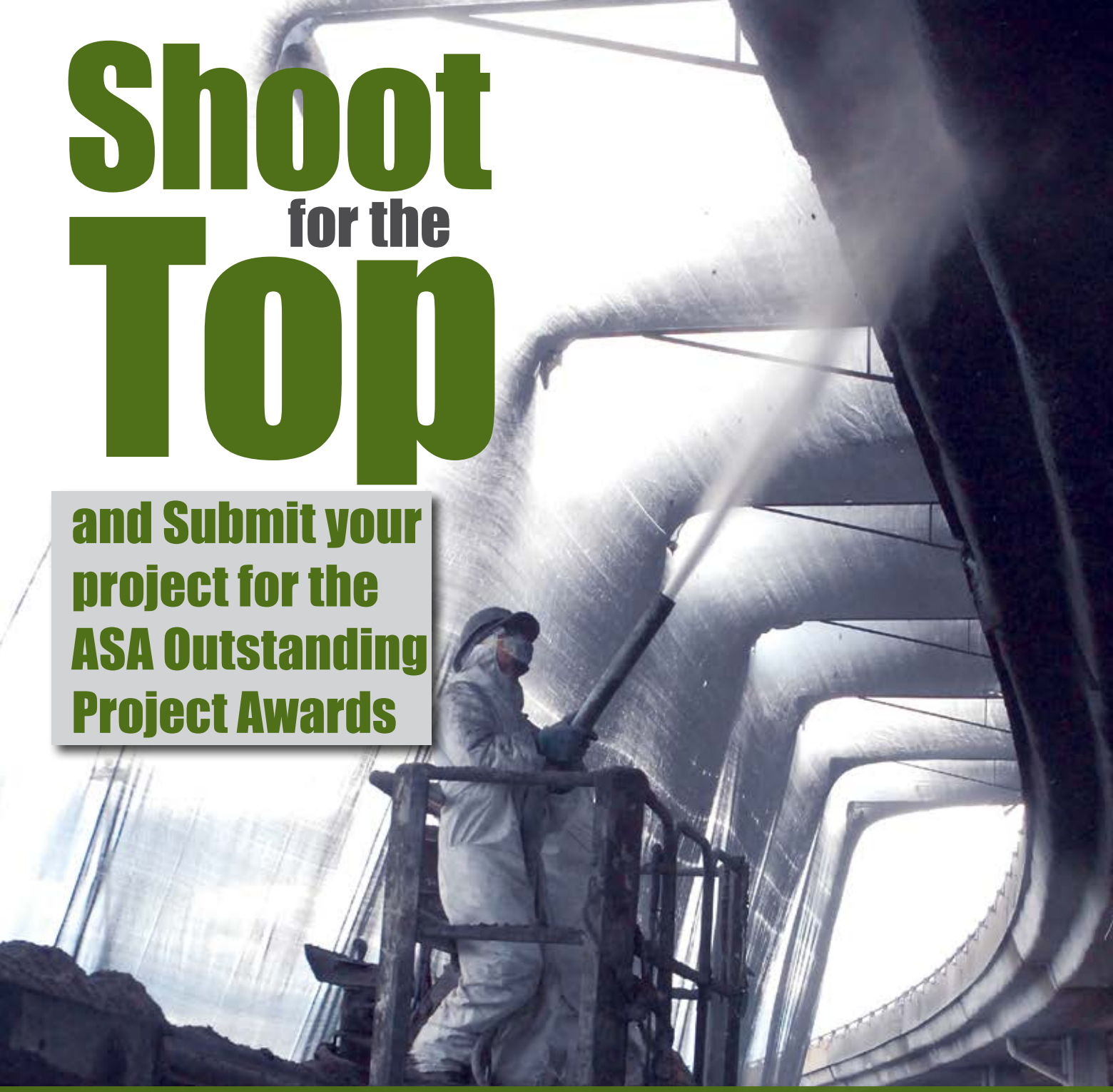

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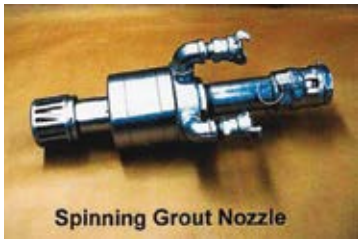
Proper Selection of Equipment and Nozzle for ACI Shotcrete Nozzleman Certification

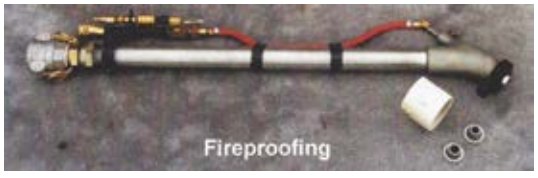
By Raymond C. Schallom III and Marc Jolin

Since the beginning of the ACI Shotcrete Nozzleman Certification program in 2001, a number of Examiners have encountered owners or nozzlemen requesting use of equipment and nozzle setups meant for low-volume/low-velocity applications such as fireproofing, plaster, stucco work, or even spin casting of sewer pipes (generally vertical layers of 1 in. [25 mm] or less). Unfortunately, none of these setups meet the true definition of shotcrete, which is "mortar or concrete pneumatically projected at high velocity onto a surface"; the **high velocity** component of this definition is critical and essential in providing superior bond characteristics and increased density, strength, durability, and toughness typical of high-quality structural concrete. All these qualities are highly desirable in the wide variety of shotcrete applications, including ground support, concrete repair, swimming pools, soil nail walls, structural walls, and lining applications. In North America, shotcrete is sometimes referred to as "pneumatically applied concrete," whereas in Europe it is more commonly referred to as "sprayed concrete."

In terms of equipment, the capacity of the air compressor controls the acceleration of shotcrete material to a high velocity as it exits the nozzle. The high velocity is essential to drive the fresh, wet material around the reinforcement and into the receiving surface (a minimum of 185 to 365 ft^3/min [5.25 to 10.5 m^3/min] if using a blowpipe for wet-mix and 600 to 750 ft^3/min [17 to 21 m^3/min] for dry-mix). The high velocity provided by an adequate flow rate of compressed air is an essential element needed to provide the excellent material properties found in shotcrete. In contrast, plaster and stucco nozzles do not supply enough air volume or ft^3/min (m^3/min) (typically only using a 1/4 to 1/2 in. [6.5 to 13 mm] supply air hose up to the nozzle) to accelerate the material adequately enough to provide high compaction or force it around the reinforcement. These nozzles were designed to apply a fine mortar material only (not concrete materials with 3/8 in. [10 mm] aggregate or fiber-reinforced concrete mixtures) at 6 in. (150 mm) or less from the surface in a splatter pattern when adjusting the 0.25 in. [6.5 mm] air nozzle. Shotcrete reference document CP-60(09), "Craftsman Workbook for ACI Certification of Shotcrete Nozzleman," clearly states that the nozzle with adequate material velocity should be between 2 and 4 ft (0.6 and 1.2 m) using a 3/4 in. (20 mm) delivery air hose for wet-mix shotcrete and 2 in. (50 mm) delivery air hose for dry-mix shotcrete.

The nozzle setups shown here *are not recognized* as shotcrete nozzles by ACI. They all have a 1/4 to 1/2 in. (6.5 to 13 mm) air lines into the nozzle.





These low-velocity spray nozzles were designed for the type of applications noted previously that need low ft^3/min to splatter the material for thin applications that do not have reinforcement to shoot around. The spin casting head is designed to fling the grout-type material onto the pipe surface, again, with no reinforcement. None of these nozzles can handle a 3/8 in. (10 mm) coarse aggregate concrete mixture with or without fibers of any type

The nozzle setups shown here *are recognized* as shotcrete nozzles for wet- and dry-mix applications by ACI.

Dry shotcrete nozzles

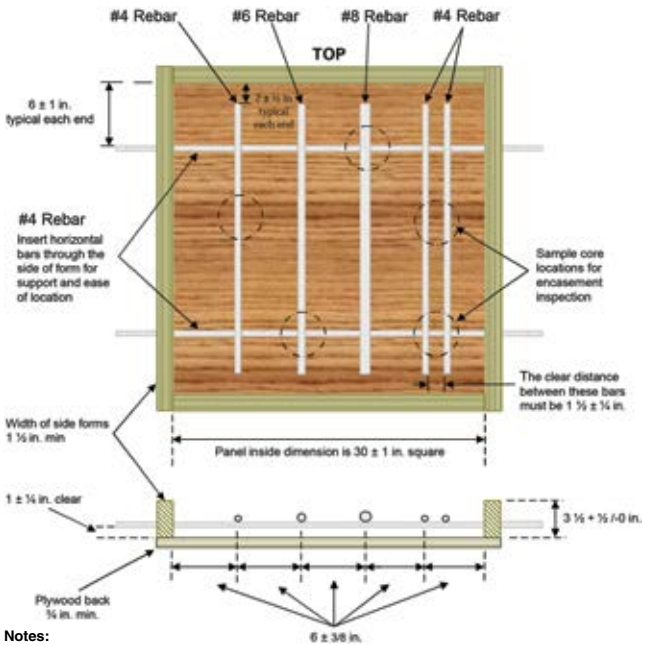
The dry-mix process nozzles are designed to handle the high material velocity and produce adequate spray patterns

Wet shotcrete nozzles

All wet shotcrete nozzles have a minimum of a 3/4 in. (20 mm) air line running into them for maximum material velocity

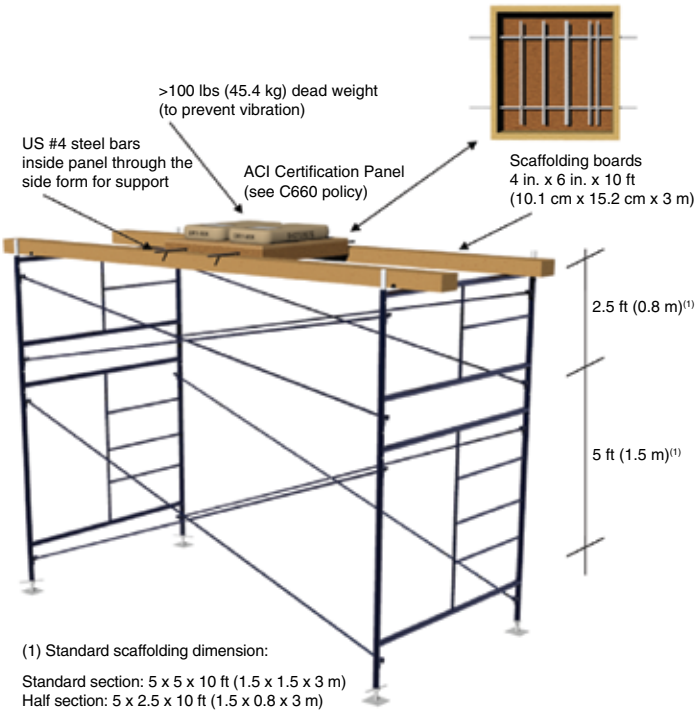
There are some who will try to convince this reading audience that low-volume, low-velocity mortar spraying is considered shotcrete spraying. Countless trial-and-error attempts have been tried throughout the years, ending up with the same result: failure. The low-volume sprayed mixtures would build up on the face of the bar and not wrap behind it, leaving voids behind the reinforcement. Spraying overhead was a bigger disaster because the material did not pack into the surface or around the bar, producing weaker bond and leaving voids, resulting in fallouts to the ground. ASA is an excellent source for archived articles that have useful information on obtaining the correct nozzles, equipment, and compressors for specific types of shotcrete projects. Many of these articles are listed for reference reading at the end of this article.

Properly shooting the standard ACI Shotcrete Nozzleman Certification Test Panel for vertical



Notes:
1. Core diameter 4 in. (nominal)
2. Core locations may be adjusted slightly at the discretion of the examiner, so long as they remain along the axis of the reinforcing bars, and at least three bar intersections are covered

Typical ACI Shotcrete Nozzleman Certification Test Panel



(1) Standard scaffolding dimension:

Standard section: 5 x 5 x 10 ft (1.5 x 1.5 x 3 m)
Half section: 5 x 2.5 x 10 ft (1.5 x 0.8 x 3 m)

Typical ACI overhead Test Panel setup

and overhead orientation is difficult if you do not have the correct shotcrete nozzle, correct ft^3/min (m^3/min), and proper delivery equipment. Many nozzlemen have learned this the hard way on job sites or during ACI Shotcrete Nozzleman Certification sessions. Shooting a coarser mixture helps keep the reinforcing bars clean when shooting through the reinforcing steel.

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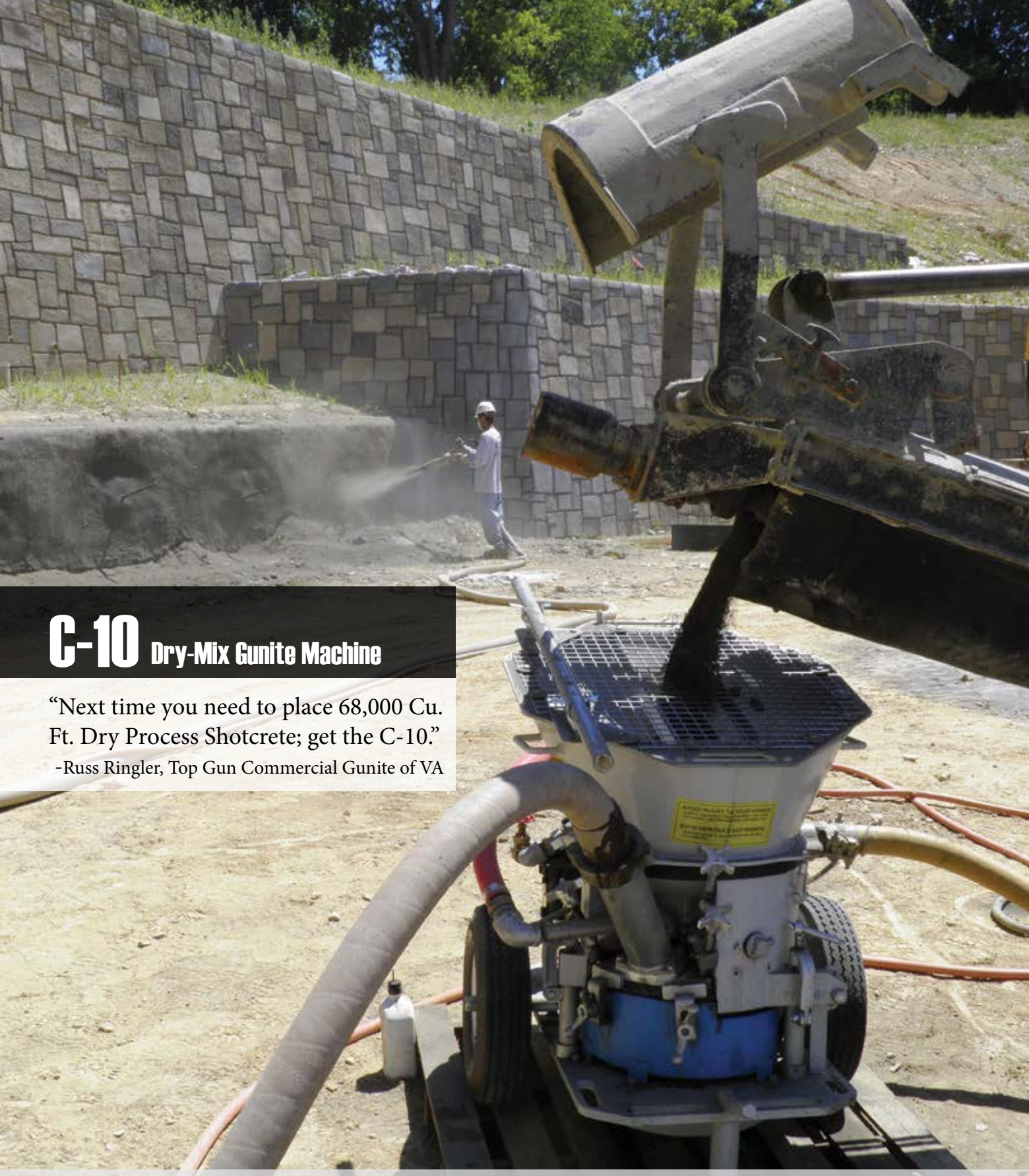
Marc Jolin *is a Full Professor in the Department of Civil and Water Engineering at Laval University, Québec City, QC, Canada. He received his PhD from the University of British Columbia, Vancouver, BC, Canada, in 1999. An active member of the Centre de recherche sur les infrastructures en béton (CRIB), he is currently involved in projects on service life, reinforcement encasement quality, new admixtures, and rheology of fresh shotcrete. Jolin is an ASA member and a Fellow of ACI. He is an ACI Examiner for Shotcrete Nozzleman Certification (wet- and dry-mix processes); Chair of ACI Committee C660, Shotcrete Nozzleman Certification; and Secretary of ACI Committee 506, Shotcreting.*



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ACI Nozzleman Certification Sessions: What Not To Do

By William T. Drakeley Jr.

As most of *Shotcrete* magazine's readership is probably aware, the American Concrete Institute (ACI) has a shotcrete nozzleman certification program for both dry- and wet-mix in vertical and overhead orientations. Much, if not the majority, of the required testing for certification is administered through the American Shotcrete Association (ASA), which includes a day of education prior to the written and performance portions of the ACI test criteria. As a very active ASA Examiner for the ACI certification process, I have had my share of testing experiences. On certain occasions, one's best-laid plans can be completely derailed. If you are considering hosting or testing for the **ACI Nozzleman Certification** or are having your employees test for it, read on for some free advice about the trials and tribulations of this certification process. In this somewhat rambling stream of consciousness, you'll find, in my humble opinion, helpful hints about what NOT to do when testing for your nozzleman certification.

Schedule

Do not pack 3 days of testing procedures into 2 days. **Leave enough time for a thorough review of the shotcrete discipline for which you are testing**. Rushing through panel shooting because you need to start a job the next day has negative effects. First, it short-circuits some of the finer points needed to complete the test. You may also give the examiner the impression that you are neither a serious examinee nor a serious contractor, thereby depriving yourself of the benefit of the doubt.

Reference Material

Read the book. Look over the fine print. Study the back pages where the actual performance exam is right in front of your face! All testing documentation is printed in ACI CP-60, "Craftsman Workbook for ACI Certification of Shotcrete Nozzleman." Continuing my point on scheduling, give the crew enough time to read and study before the examiner shows up. Let's face it—many of us feel that the hardest part of the whole certification process is the written test. Most nozzlemen did not go to Harvard (thank goodness). Having the crew pick up all study reference material the night before the exam almost always yields failed test scores. The workbook comes in both English and Spanish. ASA also makes accommodations for examiners to read the test aloud to those who know the material but have trouble with the written word. **Know the material before the examiner arrives**.

Test Disciplines

Don't take the overhead test if you do not have the required hours or experience in overhead shooting. Don't shoot a dry panel if you only do wet and vice versa. As an examiner, we can immediately tell if someone is not well-versed on a certain shotcrete process or orientation. Knowing which equipment to use based on the application also shows the examiner that you understand the process. For example, a small 2 in. (50 mm) rubber nozzle tip with no accelerator is not the tool to use in an overhead or tunnel environment. An experienced nozzleman would know this. Showing up to a day of testing underprepared in terms of equipment is a really bad sign. I would estimate that the majority of those who choose to take the overhead test do not qualify to take the test. Giving the examiner the dismissive reason that the overhead certification is required on the next job you are bidding on is not a good excuse for lack of knowledge. Even if you do luck out and pass the panel test, you may find yourself, as well as your entire application, in dire straits when you are assigned a job that is significantly more difficult than a panel (refer to Learner's Permit below). It also goes further in terms of verification, such as when an owner or agent starts looking into your overhead background experience and finds out that you have none. Couple this with your examiner's loss of credibility at the ACI testing level for passing you, and it's not just yourself you're hurting. **Test on what you know**.

Preparedness

The day the examiner arrives is not the day to set up for the testing. Make sure the scaffolding is set up at the right height and secured. Build the

test panels with the right size reinforcing bars (refer to Fig. 1) and have them correctly spaced apart. (I have found No. 10 bars [No. 30M] in panels during a session instead of the required No. 8 bars [No. 25M].) Verify the panel integrity. All these items are listed in the nozzleman certification workbook (CP-60). Rushing around and setting up the test site while the examiner is waiting can set the wrong tone for the entire session. It also puts extra stress on the already nervous nozzlemen.

Core Drilling

A handheld grinder with a 4 in. (102 mm) core bit is not a proper core drill setup. In fact, it will put you in the hospital with broken wrists. It is a good idea to have more than one core drill rig with new bits that have been tested prior to the session. If your crew does not core anything or has never seen a core drill in action, hire somebody to do it for you (refer to Fig. 2). Many cores for inspection have been wrecked by novices on the coring rig.

Panel Movement

If you find yourself underneath the shotcreted panel on the floor, it usually means you tried to move it by yourself or without adequate support and help. SLOW DOWN. Be safe and take your time. Also, do not be in a rush to trowel off excess concrete while the material is still in its plastic state. You receive no bonus points for the best-looking bottom of a panel. Besides, rushing to work or trowel the fresh shotcrete may also cause undesirable movement in the panel, which leads to cracking or other internal damage.

Ask Questions

During the educational portion of the session, please ask questions. I know the testing makes everyone uncomfortable, and examiners are not allowed to aid or assist in any way during testing. This means you must **ask questions beforehand**, even if you think those around you may know the answer, or you feel too embarrassed to say something. Most people taking the test have similar questions. Those who ask "what does this mean?" or "how will the test go and what should I look out for?" are the ones who pass.

Show and Tell

Do not invite inspectors, job owners, or future contract parties to your certification session. Something may go awry and you will need to react or switch gears. Having an audience watch you perform may be unfavorable, especially when there are pumpability issues, nozzle plugging, overhead fallout, or air-compressor troubles, which are not things you want a future client to see. Always separate a certification session from a pretest or mockup session. Too many eyes watching your every move in shotcrete testing takes the focus off the tasks at hand (refer to Fig. 3).

Fig. 1: Overhead panels prepared prior to the day of shooting, braced and set in an orderly fashion

Fig. 2: More than one core drilling rig with crews who have experience in the operation

Fig. 3: ACI panels adjacent to mockup underground section, along with 30 or so inspectors, owners, and bystanders. A small space with a big group, which is less than ideal

Learner's Permit

Do not be fooled by this certification. Passing the test gives nobody the right to take on all shotcrete applications. **This is just a simple certification identifying those nozzlemen who know the basics and can implement remedial to average placement techniques**. Successfully shotcreting sophisticated infrastructural work, underground, dome, or heavy reinforcing bar congestion is not covered in this certification. One would need to be a qualified contractor with competent crews and/or a company that has the equipment and experience to do the job. There are many in this field who take the certification and proclaim expertise in all aspects of shotcrete right away. With a job that goes sour, you not only hurt your reputation but all in the industry as well.

The ACI Nozzleman Certification is a great first step in achieving correct shotcrete application. Being prepared, testing for your strengths, and taking advantage of the educational opportunities are all practices that allow you to pass this entry-level criterion. It is a step forward into the shotcrete world. By observing and not repeating the aforementioned mistakes, this journey will not be prematurely derailed.

William T. Drakeley Jr. *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.*

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Qualifications of the Shotcrete Construction Team

By Charles Hanskat

Shotcreting is an efficient method for placing high-quality, durable concrete in a wide variety of concrete structures. Shotcrete has been successfully used in substantial number of projects for well over a century. As with cast-in-place concrete, the quality of the shotcrete placement is dependent on the quality of the materials, proper mixing and transport, substrate/subgrade preparation, the placing process, and protection until final strength is reached.

However, a comparison of the shotcrete process to the traditional "form and cast" process shows significant differences. Specifically, when using the shotcrete process:

- Formwork is eliminated or substantially reduced.
- It is necessary to identify the best shotcrete process (wet- or dry-mix) for the job.
- Special gunning equipment is required, including pumps, guns, hoses, nozzles, and admixture/water pumps.
- Knowledge is required to safely use and maintain the shotcrete equipment.
- A trained field crew that performs work totally unlike casting concrete in forms is required.
- Environmental conditions that are unsatisfactory for quality shotcreting must be identified.
- The nozzleman must be well-versed in shooting techniques, including proper air, water, and mix flow.
- The crew must be prepared to properly finish, protect, and cure freshly placed shotcrete.
- Knowledge of quality control procedures specific to shotcrete is required.

Based on these factors, it is apparent that a contractor offering to place quality shotcrete can only truly be considered a qualified shotcrete contractor if every member of the shotcrete construction team—from company management through the field team—has specific knowledge, equipment, training, and hands-on experience in the shotcrete process.

ACI 506R-05, "Guide to Shotcrete," is a great primer on shotcrete design and application. ACI Committee 506, Shotcreting, is currently working on revisions to the "Guide to Shotcrete"; in the latest drafts, the committee developed an expanded section covering shotcrete crew requirements. The following provisions are summarized to help establish field crew qualifications. The requirements for designating a contracting firm as a quality shotcrete contractor are then presented. A shotcrete team that meets or exceeds the presented crew and contractor requirements will be best qualified to provide a cost-effective, high-quality, and durable shotcrete application.

Field Team Duties and Qualifications

(based on input from ACI 506 Subcommittee developing updates to 506R, "Guide to Shotcrete")

Composition and Crew Duties

The basic shotcrete crew may consist of a foreman, a nozzleman, a finisher or rodman, an assistant nozzleman, a wireman, a gun or pump operator, a mixer operator (if needed), and laborers.

Depending on the size and complexity of the project, one person may perform more than one operation. For example, the foreman could also function as the nozzleman; one person could perform as the rodman and finisher; an assistant can help the nozzleman by both pulling the hose and operating the air-lance/blowpipe; and, if necessary, the gun or pump operator and mixer functions could be combined and, with proper equipment, performed by one person. Larger, congested reinforced projects, on the other hand, may require more than one nozzleman and air lance operator and several finishers. Where several crews are operating, a foreman, superintendent, and engineer may be required.

Shotcrete Foreman's Duties—The foreman plans, directs, organizes, and coordinates the work of each member of the shotcrete crew to obtain a safe and successful application. This includes ensuring the safety of the work area and following quality control procedures. The foreman is responsible for the inspection and maintenance of equipment, as well as ordering and expediting the delivery of materials. The foreman sets the pace of the work, maintains crew morale, ensures good housekeeping, and acts as liaison with the general supervisor or the owner's inspection team. The foreman is usually a veteran nozzleman, finisher/rodman, or pump/gun

operator and should be able to fill any of the positions if required.

Nozzleman's Duties—The nozzleman is a key person in a shotcrete operation. He is responsible for applying the shotcrete and bringing it to required line and grade in a workman-like manner. The nozzleman's duties include coordinating the application with the foreman, finisher or rodman, and pump/gun operator. Before the shotcrete is installed, the nozzleman should ensure that all areas to receive shotcrete are clean, sound, and free of loose material and that anchors, reinforcement, and ground wires are properly placed and spaced.

In the dry process, the nozzleman controls the water content for hydration and ensures that the operating air pressure is uniform and will provide high velocity at impact for good consolidation. In the wet process, the nozzleman controls the air that increases or decreases the velocity to ensure proper placement, which includes proper encasement of the reinforcement.

The nozzleman provides leadership and direction for the shotcrete crew, which aids in the task of shooting high-quality shotcrete. The nozzleman is usually an accomplished finisher or rodman and gunman/pump operator.

Wireman Duties—The wireman sets elevations and thicknesses for the shotcrete placement, which may include the top and face of the wall. Grades set by the wiremen are the lines the nozzleman and finishers will follow. The wireman may use many devices for setting grades, such as piano wire, fiberglass-metal rods, plastic pipe, and so on.

Finisher/Rodman's Duties—The finisher rods, or cuts, the freshly placed shotcrete surface, bringing it to line and grade before final finishing. The finisher also locates and removes sand pockets, sags, and sloughs and guides the nozzleman to low spots that require filling with additional shotcrete. Before the shotcrete is set, the finisher brooms and prepares the surface for final application.

Assistant Nozzleman's Duties (blowpipe/air lance control)—The assistant nozzleman helps the nozzleman by dragging the hose and performing other duties as directed by the nozzleman. The assistant nozzleman relays signals between the gunman/pump operators and may also relieve the nozzleman for short rest periods. The assistant nozzleman may operate the air lance, if one is required, to keep the areas in advance of the shotcrete free of rebound and overspray. The assistant nozzleman may be a nozzleman trainee and place shotcrete under the direct supervision of a certified nozzleman.

Gunman's Duties (dry-mix)—The gunman provides a constant flow of properly mixed dry-mix material to the nozzleman. The gunman operates and maintains a clean gun and assists in ensuring quality control. The gunman should be particularly attentive to the needs of the nozzleman to ensure that the mixture is properly prepared. The gunman generally oversees, controls, and coordinates the material mixing and delivery operation.

Pump Operator's Duties (wet-mix)—The pump operator regulates the pump to uniformly deliver the wet-mix shotcrete at the required rate. The pump operator is responsible for cleaning and maintaining the material hose and pump. The pump operator coordinates the delivery of the shotcrete mix and monitors the water content by observing or testing the slump of the mixture. The pump operator may change the delivery rate of the transit and ready mix trucks, including staging the trucks at the pump. The pump operator is also responsible for all the safety concerns of the pump and delivery line.

Mixerman's Duties—The mixerman's duties include, where applicable, the proportioning and mixing of the shotcrete mixture materials and maintaining and cleaning the mixing equipment. For field mixing, the mixerman is responsible for storage, care, and accessibility of the materials. The mixerman makes sure that the mixture is free of contaminated materials and debris and that the aggregates have the proper moisture content. He ensures a constant flow of shotcrete materials but is also careful not to mix more material than can be used within the specified time limits. The mixerman supervises the laborers who are supplying and loading the mixer.

Hose Tender's Duties—The hose tender's duties include moving tools, equipment, hoses, scaffolding, and materials. Hose tenders clean work areas, remove rebound and overspray, and provide support for the shotcrete application.

Project Engineer, Project Manager, or Superintendent's Duties—On large or complicated projects, a project engineer, project manager, or superintendent may be advisable. A shotcrete contractor usually employs engineers, project managers, or superintendents who may not be assigned to a single project full time. The project engineer, project manager, or superintendent is responsible for the material selection, mixture proportioning, preconstruction testing, qualifications of the crew, equipment selection, project planning, scheduling, logistics, materials handling, quality control, sampling and testing coordination, and troubleshooting technical problems during construction.

Crew Qualifications

General—The quality of a completed shotcrete application results from the combined skills and knowledge of the shotcrete crew. The foreman

Fig. 1: Nozzleman with his air lance man and hose tender

Fig. 2: Nozzleman, air lance man, and finisher in the background

Fig. 3: Pump, nozzleman, and hose tenders

and crew should have performed satisfactory work in similar capacities for a specified period. The entire crew is responsible for the safety of each member on any particular project.

Shotcrete Foreman—The foreman commonly has proficiency in all crew positions and is in charge of the crew and the safety procedures. The foreman typically has at least 2 years of experience in the placement of shotcrete.

Nozzleman—The nozzleman should be ACI certified (refer to ACI CP-60, "Craftsman Workbook for ACI Certification of Shotcrete Nozzleman") and have completed at least one application as a nozzleman on a similar project for the shotcrete contractor. In congested reinforced projects, the nozzleman should also be able to demonstrate, by preconstruction testing, an ability to satisfactorily perform the required duties and to apply shotcrete as required by specifications.

Assistant Nozzleman/Nozzleman Trainee—The assistant nozzleman/trainee should have 6 months of experience in a variety of shotcrete field operations that may include finishing, gun or pump operation, blowpipe/air lance control, and hose tending. The assistant should be able to demonstrate knowledge of proper shotcrete equipment setup (pump/gun, delivery hose, nozzle, and air/water supply). When shooting, the assistant must be under the direction of an ACI Certified Nozzleman.

Blowpipe/Air Lance Control—This person should have experience in finishing shotcrete and have proven successful manipulation of the blowpipe on previous jobs as directed by an ACI Certified Nozzleman, shotcrete foreman, or superintendent.

Wireman—The wireman should have at least 1 year of experience in setting grades on projects with shotcrete applications.

Rodman and Finisher—The rodman and finisher must have shotcrete experience and care must be taken not to create sags and loss of bond. Previous work experience that provided acceptable results should qualify him for this position.

Gunman or Pump Operator—The gunman or pump operator should be familiar with and able to operate the shotcrete delivery equipment, know the proper methods of material preparation and mixing, and be familiar with the chosen method of communication. The pump operator and gunman should preferably have at least 1 year of experience operating the intended equipment and be familiar with all manufacturers' safety guides and operations.

Mixerman—The mixerman should know and perform the proper methods of material preparation and mixing to consistently mix and maintain the required mixture proportions, including the proper water-to-cementitious

content ratio (w/cm). The mixerman should have a minimum of 6 months running the specific (or similar) mixing equipment used on the project.

Project Engineer, Project Manager, or Superintendent—The project engineer, project manager, or superintendent should have at least 3 years of relevant field experience.

Shotcrete Contractor Qualifications

The uniquely different needs of the shotcrete field crew and equipment, when compared to that for conventional cast-in-place concrete work, require the support, commitment, and positive attitude of the entire contracting organization for successful execution of quality shotcrete projects. Successful shotcrete projects demand full corporate support in:

1. Establishing and enforcing safety and quality control policies.
2. Purchasing and maintaining the proper equipment for each project's particular needs.
3. Committing to hire, train, and maintain the needed field personnel.
4. Handling the logistics of bidding, scheduling, and preconstruction requirements in an efficient manner.
5. Maintaining good client relationships, without which the shotcrete project may be less than successful.

The owner or specifier should always require an experienced and qualified shotcrete contractor team for executing quality shotcrete work. With this in mind, the following are suggested attributes for an owner or specifier to consider when selecting a qualified shotcrete contractor. By seeking out a contractor with the recommended qualifications below, the owner or specifier may rest assured that the **entire** shotcrete construction team—including a qualified contractor, ACI Certified Nozzleman, and experienced crew—has proven its ability to consistently place quality concrete by the shotcrete process.

Qualified contractors should have:

1. Five years of experience as a licensed contractor.
2. Five shotcrete projects of similar size, scope, and process (dry- or wet-mix) which were successfully completed within 5 years and have proper documentation, including full contact information for the owner/engineer/construction manager/general contractor, a project description, and the scope of work accomplished.
3. The ability to self-perform all shotcrete-related work and a minimum crew and staff listed as part of the company (either employees or substitutes with a work history under the current business name) consisting of the following minimum experienced field crew members:
   a. Shotcrete Foreman
   b. Nozzleman (at least one ACI Certified Nozzleman on the project)
   c. Dry-mix Gunman or Wet-Mix Pump Operator
   d. Assistant Nozzlemen/Nozzlemen Trainees (blowpipe/air lance controller)
   e. Finishers
   f. Mixerman
   g. Hose Tenders
4. Ownership of all necessary shotcrete equipment (pumps, guns, and hoses) to accomplish the job based on the specific project needs. The contractor must submit sizes and models of all shotcrete equipment to be used and should have a full equipment backup in case of equipment breakdown.
5. A certificate as a Business in Good Standing from the state that the company resides in.
6. A letter of bonding capacity from the bonding company or a letter of credit.
7. Company insurance in good standing that meets all state minimum requirements, including, but not limited to, general liability and workers' compensation.
8. ASA Corporate Membership.
9. Ability to demonstrate that members of the company construction support staff (for example, safety, general superintendent, project managers, and construction managers) have educational session credits through an industry-appropriate continuing education program specifically addressing shotcrete design, construction, or administration (ACI certifications; ASA education sessions [including ASA Onsite Seminars]; seminars; or trade shows, such as World of Concrete, ACI conventions, and ASA meetings).
10. An office or business base (with an address).
11. References (including those from the five projects in Item #2).
12. Affiliations.
13. Full disclosure of any criminal or fraudulent rulings for shotcrete work against former or current company owners in a 5-year period.

Summary

To consistently produce quality shotcrete work, the shotcrete contractor and key personnel all require proper qualifications through training in shotcrete materials, equipment, placement methods, curing, and protection to handle a particular project. It must be stressed that training in only one of these elements cannot guarantee success, and poor performance or lack of shotcrete knowledge by any member of the crew can cause a substandard finished product.

Simply specifying the use of an ACI Certified Nozzleman WILL NOT guarantee successful

shotcrete placement on a project. The ACI Nozzleman Certification program was designed to establish that the tested nozzleman is capable of shooting at an "entry" level. The nozzleman receives his certificate for each process and orientation if he succeeds in the written and the performance exam. However, the performance exam is not representative of the shotcrete application experience needed to consistently and properly place shotcrete. The shotcrete construction market has a wide range of project needs from basic, lightly reinforced, thin shotcrete sections to complex and congested structural systems requiring substantially more experience and sophisticated techniques. The wide spectrum of construction practices, shotcrete processes, performance requirements, and geographic differences can impact shotcrete placement in many ways. No certification program can address all potential variables. The ACI Nozzleman Certification program simply verifies that the certified nozzleman has basic shotcrete knowledge and has adequately shot a shallow, flat, lightly reinforced test panel. This establishes that the nozzleman has the **potential** to do a satisfactory job, once the experience required for a specific type of project is gained.

Only by selecting a quality shotcrete construction team composed of a qualified shotcrete contractor, a trained and experienced crew (including an ACI Certified Nozzleman), and the proper equipment and materials can you be reasonably assured your shotcrete project will produce the high quality, durable concrete structures that shotcrete is capable of creating.

Author's Note

The basic content of this paper was reviewed and updated by a select task group of ASA Board members with many decades of shotcrete contracting experience. The paper was submitted to the ASA Board of Directors (BOD) for consideration as an official ASA Position Paper at the Spring 2013 BOD meeting. After full Board review and approval, look for the official ASA Position Paper on our website **www.shotcrete.org**.

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Shotcrete Contractor Qualification Evaluation Checklist	
	Five years of experience as a licensed contractor.
	Five shotcrete projects of similar size, scope, and shotcrete process (dry- or wet-mix), successfully completed in those 5 years with proper documentation
	Shotcrete Contractor self-performs all shotcrete-related work and has provided an experience listing of the minimum crew to be used on the project (refer to additional checklist for the Shotcrete Field Team Qualifications)
	Owns all necessary shotcrete specific equipment (pumps, guns, and hoses) to accomplish the job based on the specific project needs. Shotcrete Contractor has submitted sizes and models of all shotcrete equipment to be used—including full equipment backup in case of equipment breakdown
	Certificate as a Business in Good Standing or equivalent from the state that the company resides in
	Letter of bonding capacity from the bonding company or a letter of credit
	Company insurance in good standing and meeting all state minimum requirements. (including, but not limited to, general liability and workers' compensation)
	Contractor is a Corporate Member of the ASA
	Contractor documents that company construction support staff (for example, Safety, General Superintendent, Project Managers, and Construction Managers) have continuing educational session credits
	Physical office, shop, or other business address
	References (preferably including those from the five shotcrete projects of similar size, scope, and shotcrete process)
	Company Affiliations (for example, ASA, ACI, AGC, and ABC)
	Contractor has disclosed any criminal or fraudulent ruling for shotcrete work against former or current company owners in a 5-year period

Shotcrete Field Team Qualification Checklist	
	Shotcrete Contractor has submitted names, positions, and experience of field team members as required for the project and generally including: 1. Project Engineer, Project Manager, or Superintendent 2. Shotcrete Foreman 3. Nozzleman (at least one ACI Certified Nozzleman on the project) 4. Gun or Pump Operator 5. Assistant Nozzlemen/Nozzlemen Trainee(s) 6. Wireman 7. Blowpipe/Air Lance Controller 8. Rodman or Finishers 9. Mixerman 10. Hose Tenders
	Project Engineer, Project Manager, or Superintendent—minimum 3 years of relevant experience
	Shotcrete Foreman—minimum 2 years of shotcrete experience
	Nozzleman—holds current ACI Nozzleman Certification appropriate for the work and has completed at least one similar application as a nozzleman on a similar project for the Shotcrete Contractor
	Gunman or Pump Operator—should have at least 1 year of experience operating the intended equipment and be familiar with all manufacturers' safety guides and operations
	Assistant Nozzleman/Nozzleman Trainee—should have 6 months of experience in various shotcrete field operations that may include finishing, gun or pump operation, blowpipe/air lance control, and hose tending. When shooting, must be under the direction of an ACI Certified Nozzleman
	Wireman—should have a minimum of 1 year of experience in setting grades and profiles on shotcrete work
	Blowpipe/Air Lance Controller—should have experience in finishing shotcrete and have proven successful manipulation of the blowpipe on previous jobs as directed by an ACI Certified Nozzleman, Shotcrete Foreman, or Superintendent
	Rodman or Finisher—has proven successful shotcrete finishing on previous shotcrete projects
	Mixerman—should have a minimum of 6 months of experience running the specific (or similar) mixing equipment in use on the project

Shotcrete Contractor Qualification

By Marcus H. von der Hofen

It's been over a decade since the inception of the ACI Shotcrete Nozzleman certification programs, which many individuals within the American Shotcrete Association (ASA) and the American Concrete Institute (ACI) worked extremely hard to create. Many thought that certification should have been done at the contractor level. Through hours of debate and consensus building, however, ASA moved forward in formalizing the shotcrete nozzleman programs.

The ACI Shotcrete Nozzleman certification programs were designed to be at a "baseline" level. The nozzleman receives a certificate for each shotcrete process (dry- and/or wet-mix) and orientation (vertical with or without overhead) if successful in both the written and the performance exam(s). They were not intended to be the most rigorous exams possible. The shotcrete industry has a wide spectrum of applications, practices, shotcrete processes, performance requirements, site constraints, and geographic differences. Correspondingly, a wide range of project needs exists, from lightly reinforced basic shotcrete to heavily reinforced concrete sections with complex geometry and limited access requiring much more sophisticated workmanship. No single shotcrete certification program can address all the variables one may encounter on a project.

The ACI certification programs focus on certain and specific key elements (knowledge, skills, and abilities) deemed by knowledgeable committee and industry members to be the most essential for general applications. They consist of a general-knowledge written examination and a performance examination that includes shooting an actual test panel containing reinforcing steel. The test panel is 30 x 30 x 3.5 in. (800 x 800 x 90 mm) deep and contains a single layer of reinforcing steel of different sizes and spacing. Thus, they are basic—they neither simulate deep sections, multiple layers of reinforcing, or obstructions, nor do they address bonding and surface preparation. After hardening, the panel is cored for evaluation in accordance with prescribed procedures. Evaluation is primarily based on the degree of encapsulation of the reinforcing steel. The certification programs verify the certified nozzleman knows the basics of both general knowledge and performance technique and has the **potential** for satisfactorily placing shotcrete. Again, this certification alone is not a guarantee that this nozzleman is then able to place shotcrete in all applications and degrees of difficulty as exists in the field. There is no substitute for documented experience in the shotcrete application at hand.

What has been left out of the ACI Shotcrete Nozzleman certification programs is the fact that the nozzleman did not gain shotcrete nozzling experience and get certified *on his or her own*. The fact is that much of the field operation needed for nozzling success is not necessarily under the nozzleman's direct control. The diligent work of a qualified shotcrete contractor, who provides the right mixture design, properly sized and maintained equipment, the guidance of an experienced nozzleman, and additional shotcrete crew members (for example, gunman, pump operators, finishers, and hose tenders), is essential because it gives the nozzleman trainee the opportunity to learn quality shotcrete placement before being certified. **Specific project qualifications** are achieved if the **contractor, key personnel, material, equipment**, and **placement methods** are either known to meet the requirements (that is, previous successful work experience/contractor prequalification) of the project or proven through preconstruction testing. It cannot be stressed enough that satisfactorily meeting any one of the elements alone cannot guarantee success; however, failing any one of them can cause a substandard finished product.

Currently, the owner or specifier of a specific project must consider the experience of the shotcrete contractor, nozzlemen, and field shotcrete crew before deciding when to require a comprehensive preconstruction qualification program. When considering prequalifying the shotcrete contractor, it is vital that sufficiently documented projects that involved similar challenging applications using the proposed nozzlemen, crew, and procedures be provided and verified. The criteria for waiving preconstruction testing procedures for highly experienced shotcrete contractors should be detailed in the project specifications and should clearly establish the highest level of previous experience required. When contractor prequalification is not used, applicable, or available, project preconstruction testing with mockups should be considered. There is a significant cost associated with a preconstruction testing program, and this should be considered in developing the contract requirements (refer to Fig. 1).

A program to provide shotcrete contractor qualification is the next step in assuring that the shotcrete industry remains credible and has integrity in the years to come. Nozzleman certification is one part of the equation. An even more important variable is shotcrete contractor qualification. For example, if a certified nozzleman completes a project today and it fails a year from now, who is going to be held responsible for the failure? The contractor. The contractor will have to return to the site and remedy the problem with or without the certified nozzleman who completed the project. This is why shotcrete contractor qualification is as, if not more, important than nozzleman qualification; it takes an entire team to have a successful project, not just a nozzleman with credentials.

An increase in funding allocated for the rehabilitation and repair of the country's infrastructure has resulted in an increased number of fly-by-night shotcrete contractors. While competition is healthy and encouraged, these fledgling contractors with no shotcrete experience should not be allowed to simply hire a certified nozzleman and have equal bidding capability with a well-established, experienced contractor who has successfully completed similar projects over the past several years.

There is a difference between the two contractors. A qualified contractor not only has certified nozzlemen but also has the equipment, crew, management, bonding capacity, and references, which set him or her apart from the contractor with a pump and a certified nozzleman. It is important to make this distinction to private and public owners in the project specifications to avoid confusion regarding the class of contractor bidding on their project (refer to Fig. 2).

The vision statement of ASA in 1998:
To have the shotcrete process understood and used in every beneficial application.

The ASA Mission Statement:
To encourage and promote the safe and beneficial use of the shotcrete method.

As a charter member of ASA, I believe it is our duty to follow these statements, and who better to help the specifiers, owners, and municipalities than ASA with a Shotcrete Contractor Qualification program—a program that is maintained and can adapt as required to meet the needs of our mission. Our educational goal is not to create or train new contractors/nozzlemen but to encourage the safe and proper use of this unique method of concrete placement. Encouraging shotcrete use by providing a qualification standard will help meet this goal. This will not be an easy task, but it is one that has to be undertaken.

Fig. 1: A typical preconstruction test panel with congested reinforcement

Fig. 2: Properly placed shotcrete is a team effort: the pump, mixer, and nozzlemen are pictured here

***Marcus H. von der Hofen**, Vice President of Coastal Gunite Construction, has nearly two decades of experience in the shotcrete industry as both a Project and Area Manager. He is an active member of American Concrete Institute (ACI) Committees 506, Shotcreting, and C660, Shotcrete Nozzleman Certification. He is a charter member of ASA, joining in 1998, and currently serves as Secretary to the ASA Executive Committee.*

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The Learning Curve

Nozzleman Qualification for New York City Subway Tunnels

By William T. Drakeley Jr.

The MTA CC/Long Island Railroad/East Side Access Project is an extension and new installation of subway tunnels, shafts, and cross passages for the New York City metro area. These new subway systems and adjoining connections allowed the use of the shotcrete process, based on certain criteria specified by bid documentation. This was to be the first major infrastructure use of shotcrete within the boundaries of New York City.

Fellow shotcrete experts and I have watched this project unfold with a certain level of anticipation. Our primary preoccupation was to ensure proper shotcrete placement was conducted safely by a qualified workforce in an underground environment. However, the New York City underground workers—who initially lacked any knowledge of the shotcrete process—needed to be trained and acclimated to the proper and safe application of shotcrete. I was hired to qualify workers for the project. Once the workers were qualified, I remained on the project as a consultant and led oversight to the work in progress at the request of the project owner. From the outset of the shotcrete production, the learning curve for proper application techniques had to be successfully undertaken at an accelerated pace. Given the unprecedented nature of the project, the stakes could not have been higher for the future use of the shotcrete process in the greater New York City metropolitan area.

Specifications

The design specifications required each person applying shotcrete to demonstrate acceptable proficiency, which was defined as application that met the requirements of both the specification and the proficiency requirements of ACI Committee C660, Shotcrete Nozzleman Certification. The contractor was also required to provide operators qualified to perform work conforming to requirements of ACI 506R, "Guide to Shotcrete," and ACI 506.3R, "Guide to Certification of Shotcrete Nozzlemen" (this document has been withdrawn by ACI because all nozzleman certification efforts now fall under ACI Committee C660), with operators certified according to the requirements of the ACI Shotcrete Nozzleman Certification program.

The ACI Shotcrete Nozzleman Certification program, developed and maintained by ACI Committee C660, is a program for certification of nozzlemen employed for the application of dry- or wet-mix shotcrete. While an ACI Certified Nozzleman would be able to demonstrate basic knowledge and skill in shotcrete application, there are other aspects involved in shotcreting in an underground environment that require specific additional training. There are many craftsmen in the underground construction community that have skill and experience in concrete, including some experienced in shotcrete application for ground support and familiar with the needs for safety and work-related qualifications in the tunnel environment. However, they are not ACI-certified nozzlemen, and, unfortunately, the educational curriculum and the performance test (structural test panel) do not directly relate to placing underground shotcrete. The test is therefore not necessarily useful in assessing the ability of a person to apply shotcrete in an underground construction application.

ACI Committee C660 is not presently considering a curriculum or certification specific to tunnel and mining applications. It is important to note that the original ACI 506.3R was a nonmandatory guide for an engineer who wished to design a program for nozzleman certification to include in a project specification. Even though many specifications list it as such, ACI 506.3R was never a certification program in and of itself. In fact, one of the reasons the guide was officially withdrawn was because of the confusion it often created when blindly referenced in a project specification.

Training

Due to the lack of official training programs for shotcrete applications in the underground environment and the overwhelming need for such education, we recommended that a program

following the applicable training curriculum and examining procedure of ACI Committee C660 be established for the purpose of qualifying craftsmen for application of shotcrete specific to the requirements of each underground project. This was not and could not be an ACI-sponsored program, but it was deemed acceptable by the project engineer after a comprehensive review. The program was developed and presented by qualified, credentialed ACI C660 examiners and educators.

This new training and qualification program required background information describing previous shotcrete experience, which was submitted either by the individual or the union for each candidate. The shotcrete "résumé" was reviewed by the project engineer, the examiner/educator, and others as required.

This program incorporated classroom instruction of 4 to 6 hours, including topics such as basic concrete technology and practice, shotcrete application, equipment operation and maintenance (directly related to shotcrete), ground support in various conditions employing shotcrete in combination with rock bolts, lattice girders and other support components, quality control, safety specific to shotcreting, and project requirements. It also included field trials such as practice shooting, the shooting of test panels to demonstrate application skills, and lab testing to confirm quality of materials placed. Finally, the program required field supervision by a qualified examiner/educator during initial shotcreting by the nozzleman on the project.

One of the priorities of this program was to ensure the continued presence of quality assurance and inspection personnel employed by the owner and designer, as well as quality control efforts by the contractor. The ongoing quality assurance and inspection were provided by the same examiner/educator that conducted the educational portions of the program and observed the field trials. In this way, all parties involved in the placement and acceptance of shotcrete on the project were in harmony.

General Conditions

The new shotcreting program hit four initial obstacles. First, under Contract CM019, the east and west caverns, in addition to all adjoining cross passages, Y caverns, and shafts, were to be drilled and blasted. With each blast, material was excavated and moved to a crusher in the lower levels. It was then loaded onto an underground conveyor belt and transported north, from Midtown Manhattan past Northern Boulevard in Queens. This excavation activity involved a three-shift nonstop rotation. Each underground phase was scheduled by set internal timetables. Because we were "the new guys on the block," we were given low priority and had to fight for (time) space (refer to Fig. 1).

Fig. 1

Fig. 2

Secondly, this rock removal schedule also left us with the task of reaching nearly inaccessible areas of rock wall and ceiling (refer to Fig. 2). We encountered overbreaks in the excavation up to 10 ft (3 m) and overall ceiling heights that extended beyond 50 ft (15 m). The difficult access inherent on this project made continuous shotcrete application impossible. We would start one section, only to have to stop and move elsewhere, due to terrain passable only on foot or by mountain goat.

A third obstacle, which emerged in the first quarter of shotcrete applications, was the fact that our crew—Sand Hogs provided by Local #147 and some #731 Laborers—as the shotcrete underground workforce, was not allowed to service the shotcrete equipment. Due to the scope and logistics of the project, this task was the responsibility of other union crews equipped with workers and tools and established to carry out a variety of maintenance tasks in all aspects of the project. Although this is efficient for most operations, electrical and mechanical services were often not available when required on our project, which resulted in downtime and quick changes in procedure. Available maintenance crews had a variety of workers with vastly different talents. While the range of expertise was ultimately an asset to the project, in the short-term, it inhibited a uniform and productive shotcrete application. For example, if a large robotic machine went down and was in dire need of service, its maintenance received no priority but was added to the list on a "first-come, first-served" basis.

Fig. 3

Fig. 4

The final obstacle was that the areas to be shotcreted were also high-traffic sites, accessed by workers in many trades. It was a bottleneck for all those involved and made implementation of the shotcrete process and schedule very challenging.

Shotcrete

As the accepted training and qualification program was put into place, we began our journey along the learning curve. The crews and management settled on hand-nozzling with the aid of man lifts. This was an important stance to take in deference to the qualifications of the workers. We strongly believe that no matter how many classroom sessions we had (2 full days for each nozzleman, on average) or how many hours were spent perfecting technique on the robotic machines, the best way to learn quality shotcrete placement was to actually grab the nozzle and shoot by hand.

Under the observation of a qualified supervisor or previously qualified job foreman, we could start with the nozzle in a low-risk wall or bench shooting to acquire hours of practice. Full qualification came after an accepted number of hand-nozzling hours were documented by the approved qualification trainer. It was of great benefit for the nozzleman to have a qualified trainer by his side, giving tips while shooting or discussing key issues with the foreman so he, in turn, could relay advice to the general crew. It should be pointed out that our qualification was geared toward the entire crew and full shotcrete process, not just the workers holding the nozzle.

Both dry- and wet-mix shotcrete materials and equipment were used. With a 6 in. (150 mm) slick line, wet-mix concrete was sent from the street through a re-mixer down to the tunnels and into the Putzmeister Shotcrete Technologies' shotcrete pumps. Despite both the harsh physical environment and the carelessness demonstrated by some tradesmen in moving equipment from one

shooting location to the next, the pumps withstood the abuse and operated successfully.

According to the specifications, all the large-volume shooting was to be done with wet-mix (refer to Fig. 3). Some smoothing or short patching was handled with dry-mix. For the most part, the dry-mix placement on the project employed full skid-mounted guns with pre-dampeners from Putzmeister. The dry-mix material supplier used, after a thorough vetting process, was King Packaged Materials Company.

The crews had to understand more than just basic shotcrete (refer to Fig. 4). We used a sophisticated shotcrete mixture that included hydration control chemical dosing of concrete intended to sit for hours, yet remain plastic and pumpable without separation; be pumped up to and beyond 2000 ft (600 m); and make it to the nozzle without plugs despite being fiber-reinforced. Especially in overhead areas, the shotcrete material needed to have an accelerated set once sprayed, yet retain some plasticity for shaping or rough finishing. Each nozzleman could see firsthand how important angle, velocity, mixture design, and equipment manipulation (such as man lifts) were to the overall success of the job.

Our job was always made more difficult by the requirement to add reinforcement to some of the rock substrate (refer to Fig. 5). Welded wire was attached to the rock bolts, and, on occasion, a metal mine strap was adhered to potentially loose rock material. These reinforcement requirements (overly reinforced in my humble opinion) likely reduced the bond of the fresh shotcrete to the rock substrate. Nozzle movements had to be perfect in and around a mine strap and where welded wire sheets overlapped, but we had virtually no access to the rock substrate behind the reinforcing material. In those few areas where the mesh overlapped, we adeptly cut out the overlapping layer to allow proper shotcrete application and a good bond to the rock facing.

Current Status

According to Sean Clevenstine, General Superintendent of Concrete at Schiavone Construction, who oversaw the shotcrete applications on the project:

"Simple mathematics can be used to show the effectiveness of the program. In early 2011, our production goal based on past performance before the program took effect, was 40 yd^3 (31 m^3) of shotcrete placement per

Fig. 5

day, spread over three 8-hour shifts. By project completion, we were capable of applying over 200 yd^3 (150 m^3) in a 24-hour period, per heading, with rebound hovering between 5 and 10%. For a project of this magnitude, it wouldn't have been possible to get those numbers without a comprehensive training and evaluation program in place. What I believe made our program effective was the fact that it was "graduated." It took individuals with little or no exposure to the application process and walked them through each step, under a 'qualified supervisor.' The end result was a highly productive, exceptional quality product. It also validated the craft members of Local #147 as 'expert' nozzlemen by the time they completed all of the steps for qualification."

As of June 2013, we have qualified over 35 nozzlemen in the last 5 years for this and related projects. Most are from the #147 Sand Hog Union. The total amount of early ground support surface area sprayed is 1,000,000 ft^2 (93,000 m^2). The yardage installed for the MTA CC/Long Island Railroad/East Side Access Project regarding the early ground support phase of the project is nearly 46,000 yd^3 (35,000 m^3) of wet-mix shotcrete application and another 10,300 yd^3 (7900 m^3) of dry-mix shotcrete. Mid-June 2013 marked the completion of the bulk of the project, not including punch-list items. The current talent pool of nozzlemen in New York City should now be considered as competent and viable a labor force as any in the underground shotcrete world. It is said of New York City that "if you can make it here, you can make it anywhere." Now, for the shotcrete process, that promise holds especially true.

The author (left) wishes to acknowledge the contributions of George Yoggy (right) to this article

William T. Drakeley Jr. *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.*

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U.S. Shotcrete Standards Update

By Charles Hanskat

This article is dedicated to Pete Tatnall, a founding member, Past President, and Board member of ASA; a past Chairman and active member of various ASTM International committees dealing with fiber and shotcrete; and a longtime active member of American Concrete Institute (ACI) Committee 506, Shotcreting. He was a regular contributor to *Shotcrete* magazine and provided regular updates to Shotcrete Corner with articles on U.S. shotcrete standards. With great sorrow, we note that Pete passed away April 26 of this year after a long, valiant 18-month battle with illness. Pete was a great contributor to the shotcrete industry who readily shared his knowledge and experience with members and committees of ACI, ASTM International, and ASA. He will be greatly missed.

It's been over 5 years since we last updated our reference list of shotcrete-related standards and specifications. In that time, we've seen a significant increase in activity by various standards developing organizations in creating new documents incorporating shotcrete and updating their existing documents. Readers are requested to contact the editor and author if inaccuracies are found in the following report, if additional activities should be reported, or if new activities should be initiated.

ACI (www.concrete.org)

ACI Committee 506, Shotcreting, is currently chaired by Larry Totten; and Marc Jolin serves as Secretary. The committee is divided into subcommittees and task groups, each concerned with a specific document or issue. The subcommittees are working on:

- ACI 506.2-95, "Specification for Shotcrete": The specification has been completely revised and balloted through the subcommittee (506-E) and the main committee, passed Technical Activities Committee (TAC) review, and undergone a public review period of 45 days. The main committee has balloted the responses to public comments. It is anticipated that the new version, ACI 506.2-13, will be available for purchase later this year.
- ACI 506R-05, "Guide to Shotcrete": The subcommittee (506-C) is working on revisions to this document. The development of revised text is completed in the subcommittee and will be balloted to the main committee before the ACI Fall 2013 Convention. As the Guide is a nonmandatory document and serves as a "primer" on shotcrete for the industry, good photos are an important component of the document. Watch your e-mail, as ACI Committee 506 may request photos from members of ASA for specific aspects of shotcreting for the Guide.
- ACI 506.1R-08, "Committee Report on Fiber-Reinforced Shotcrete": Pete Tatnall was Chair of this subcommittee (506-B) and completed revisions to the 1998 version of the document. The current Chair, Jeff Novak, is working with the subcommittee on revisions to the document.
- ACI 506.4R-94 (Reapproved 2004), "Guide for Evaluation of Shotcrete": Marc Jolin, Chair of the subcommittee (506-A), has revised the document within the subcommittee and is planning a ballot on proposed revisions for the main committee before the ACI Fall 2013 Convention. A new section on "Acceptance of Shotcrete" is concurrently being developed by Jim Ragland.
- ACI 506.5R-09, "Guide for Specifying Underground Shotcrete": Pete Tatnall also chaired this subcommittee (506-F), which prepared ACI Committee 506's newest document. This document serves as a guide for engineers and owners who are specifying shotcrete for underground applications. It is not a construction specification geared toward the contractor that can be directly incorporated into contract documents for a specific project (such as ACI 506.2-95) but serves to provide specifiers guidance on what is needed in their particular project specification.
- ACI Committee 506 new document, "Guide for Contractor Qualifications for Specific Projects": Chaired by Marcus von der Hofen, this subcommittee (506-G) is close to finishing the document within the subcommittee. The

next step for the document will be balloting to the main ACI 506 committee. The ACI Committee 506 leadership is also considering incorporating the material into the revised "Guide for Evaluation of Shotcrete" rather than publishing it as a stand-alone document.

- ACI Committee 506 new document, "Tech Note for Visual Evaluation of Shotcrete Core Quality": Chaired by John Zhang, this task group is developing a Tech Note to provide a reference for visual evaluation of shotcrete quality using cores. As with the "Guide to Shotcrete," good-quality images are key to the usefulness of the document. Watch your e-mail, as ACI Committee 506 may request photos from members of ASA of specific examples of cores.
- ACI 506 new document, "Tech Note on Acceptance of Shotcrete": Chaired by Jim Ragland, this task group is working on a document to address acceptance criteria of shotcrete. Because the scope and complexity of shotcrete projects can vary widely, the task group is developing the concept of "Application Difficulty Level" and establishing corresponding acceptance criteria that can vary with the application. The ACI Committee 506 leadership is also considering incorporating the material into the revised "Guide for Evaluation of Shotcrete" rather than publishing it as a stand-alone document.
- ACI C660: Both English and Spanish versions of CP-60(09), "Craftsman Workbook for ACI Certification of Shotcrete Nozzleman," are available from ACI and were updated by ACI Committee C660, which is chaired by Marc Jolin.
- ACI 350.5-12, "Specifications for Environmental Concrete Structures": This is a new document produced by ACI Committee 350, Environmental Engineering Concrete Structures. It is a construction specification similar to ACI 301 but intended for liquid-containing structures rather than buildings. Because shotcrete is widely used in environmental structures, it addresses both concrete and shotcrete.

ASA members continue to play a significant role in the leadership of ACI Committee 506 and contribute to the efforts of the subcommittees. Readers should contact the subcommittee Chairs if they have contributions.

It should be noted that the only ACI Committee 506 document mentioned that can be directly incorporated by reference into project specifications is ACI 506.2R-95 (hopefully soon to be replaced by ACI 506.2-13). If portions of any of the other documents are appropriate for the project specification, the applicable language should be put into mandatory language and inserted by the specifier into the project specification. ACI Committees 506 and C660 and subcommittees will meet in Phoenix, AZ, during the ACI Fall 2013 Convention.

ASTM International (www.astm.org)

ASTM International Committee C09, Concrete and Aggregates, continues its work on specifications and test methods for shotcrete. The C09 committee and most subcommittees met in Indianapolis, IN, June 10-12, 2013, to work on the latest ballot activities for revising documents and developing new ones. The author is a voting member of ASTM Committees C09, Concrete and Concrete Aggregates, and ASTM Subcommittees C09.46, Shotcrete; C09.64, Nondestructive

and In-Place Testing; and C09.66, Concrete's Resistance to Fluid Penetration. The author also attended the committee meetings. The current status of these committees is reported as follows.

The C09.46 subcommittee outgoing Chair is Mark Lukkarila and the incoming Chair is Richard Schwartz. The C09.46 subcommittee is responsible for the following standards:

- ASTM C1140/C1140M-11, "Practice for Preparing and Testing Specimens from Shotcrete Test Panels": The document is current and not under active revision.
- ASTM C1141/C1141M-08, "Specification for Admixtures for Shotcrete": The document is currently being considered by the committee for revision.
- ASTM C1385/C1385M-10, "Practice for Sampling Materials for Shotcrete": The document is current.
- ASTM C1398-07, "Standard Test Method for The Laboratory Determination of the Time of Setting of Hydraulic Cement Mortars Containing Additives for Shotcrete by the Use of Gillmore Needles (Withdrawn 2010)": The document was not updated and due to limited use has been withdrawn by ASTM International.
- ASTM C1436-08, "Specification for Materials for Shotcrete": The current document is being revised and will be in balloting.
- ASTM C1480/C1480M-07(2012), "Specification for Packaged, Pre-Blended, Dry, Combined Materials for Use in Wet or Dry Shotcrete Application": The document was recently reapproved by the committee.
- ASTM C1604/C1604M-05(2012), "Standard Test Method for Obtaining and Testing Drilled Cores of Shotcrete": This document was recently reapproved by the committee. It is currently being evaluated for revisions by the task group of Curt White and the author.

Many members of the shotcrete subcommittee are also members of ASTM Subcommittee C09.42, Fiber-Reinforced Concrete. Documents from this subcommittee that are useful for shotcrete include:

- ASTM C1550-12a, "Test Method for Flexural Toughness of Fiber-Reinforced Concrete (Using Centrally Loaded Round Panel)": Because this test method has been used primarily to characterize fiber-reinforced shotcrete to date, there is continuing interest by ASTM Subcommittee C09.46, ACI Committee 506, and ASA members. This test method is current.
- ASTM C1609/C1609M-12, "Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading": This is another fiber-reinforced test standard used in the shotcrete industry. It is current with ASTM.

ASTM Subcommittee C09.66 also met at the June 2013 ASTM Committee Week. In discussions there, the subject arose of the pertinence of ASTM C642-13, "Standard Test Method for Density, Absorption, and Voids in Hardened Concrete." The document status is current, but there was discussion that the description and purpose of the test need revision. This will be considered by the subcommittee as new business. The outgoing Chair is Toy Poole and the incoming Chair of C09.66 is Ken Snyder.

Readers are encouraged to contact the aforementioned Chairs or the author if you have questions or if you are interested in participating in the development of documents concerning the use of shotcrete.

Charles Hanskat, ***PE***, *is Managing Principal at Hanskat Consulting Group, LLC, a firm he founded in 2012 located in Northbrook, IL. He received his BS and MS in civil engineering from the University of Florida. Hanskat is a licensed professional engineer in 23 states. He has been involved in the design, construction, and evaluation of environmental concrete and shotcrete structures for over 35 years. Hanskat is an ASA Vice President, Board member, and Chair of the ASA Sustainability Committee. He is also a member of ACI Committees 301, Specifications for Concrete; 350, Environmental Engineering Concrete Structures; 371, Elevated Tanks with Concrete Pedestals; 372, Tanks Wrapped with Wire or Strand; 376, Concrete Structures for Refrigerated Liquefied Gas Containment; and 506, Shotcreting; and Joint ACI-ASCE Committee 334, Concrete Shell Design and Construction. Hanskat's service to the American Society of Civil Engineers (ASCE), the National Society of Professional Engineers (NSPE), and the Florida Engineering Society (FES) in over 50 committee and officer positions at the national, state, and local levels was highlighted when he served as State President of FES and then as National Director of NSPE. He served as a District Director of Tau Beta Pi for 25 years from 1977 to 2002. He is a Fellow of ACI, ASCE, and FES and a member of ASA, NSPE, ASTM International, AWWA, NFPA, and ASCC.*

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Can You Pass the Strength Panel Test?

By Oscar Duckworth

Often Overlooked Requirements That All Nozzlemen Need to Know

Author's note: The purpose of this article is to provide insight on the proper placement and care of test panels required for strength development testing only. *Test panels are used in a number of varying situations, and it is important to note that this article does not address the particular concerns for all panels shot for other purposes. Although practices presented within this text should not be overlooked, test panels shot for core grading purposes, such as for the ACI Nozzleman Performance Evaluation, require far more discussion of nozzle techniques than could be responsibly covered in this article. This topic will be covered in a future Nozzleman Knowledge article.*

Nearly everyone in the shotcrete industry is familiar with test panels. To the shotcrete professional, it is simply a compulsory ritual of our daily routine. We shoot the panels, cores are extracted from panels, and the cores are tested for strength compliance. Numbers are always good. But what if something goes wrong? Do the nozzleman and crew share responsibility for strength values?

Many shotcrete workers possess little knowledge about the proper handling and storage of a typical test panel. Casual research seems to indicate that most workers know that, once shot, panels should not be moved…or dropped.

How much do you actually know about the proper care of a typical test panel? Are you confident that you are currently creating and handling test panels in an approved manner? If not, don't worry. A few low-strength test panels are sure to draw plenty of attention to your company's test panel protocol.

"Produce a material test panel for each mixture and each work day or every 50 yd^3 (38 m^3) placed, whichever is less." (Typical specification)

Studying for the Test Panel Test

Experienced shotcrete craftsmen know that the ultimate quality of in-place shotcrete is largely dependent on the skill and knowledge of the placement crew. Shotcrete must be carefully placed, consolidated, and cured to gain its full design strength. When we shoot the test panel, placement techniques and materials should mirror the in-place work. Many times after a test panel is shot, however, it is generally forgotten. Mishandling, improper storage, or insufficient curing can result in test panels with less than half their strength potential. When test results come up low, it can be difficult to determine if low core strengths are caused by poor test-panel shotcrete placement, handling practices, or other factors.

"Using techniques that assure a repeatable standard of care for each test panel should be a component of every shotcrete worker's education program."

Test panel placement, early-age handling, and protection techniques are crucial to allow the maximum strength development of shotcrete test specimens. But many shotcrete workers lack specific knowledge about these important practices. Currently, various ACI and ASTM documents provide guidance on the proper care, handling, and storage of shotcrete test panels.

The First Step: Correctly Shoot the Panel

Any test panel used to determine a shotcrete mixture's compliance with job specifications should closely match the actual placement condition. This is one of the reasons we derive strength data from cores extracted from test panels rather than cast concrete cylinders. If a mixture is to be pneumatically applied, the mixture's properties should be tested following placement by the same procedure. Unfortunately, the act of shooting a test panel may introduce unexpected variables that can dramatically affect test results. A nozzleman who is responsible for shooting a test panel must be able to correctly place material in a manner that will not significantly alter its hardened properties.

Poorly shot panels are susceptible to various internal flaws that will negatively affect strength. Similar to other difficult-to-shoot areas, placement of the test panel requires precise nozzle techniques to attain satisfactory results. Skilled nozzlemen are aware that the size of the test panel

Fig. 1: Poor placement techniques have produced sand lens or encased rebound trapped within test specimen

Fig. 2: Nozzleman initially places material into the panel's lower corners while close in

Fig. 3: As the panel fills, the nozzleman adjusts the angle and backs away to avoid displacing in-place material. Note continuous use of a blow pipe

affects placement difficulty. This is primarily due to the placement accuracy required to fill small elements. Nozzle orientation, angle, material volume, air flow, slump, and blow-pipe techniques become more critical when filling small areas.

Whereas nozzle velocity is a primary element in material consolidation and compaction, excessive velocity can shove, displace, or fold material when placing a test panel. Poorly chosen placement angles, distance, or incorrect nozzle flow can disturb in-place material within the panel. Internal cracks, voids, laminations, or sand lenses can result. Additionally, because test panels have formed perpendicular edges, the potential for trapped rebound pockets or sand lenses within the in-place material can intensify if panels are not placed skillfully (refer to Fig. 1).

Prior to placement of any test panel, nozzlemen should ensure that the panel is sufficiently rigid to withstand placement pressures without movement. Nozzlemen should reduce placement volume and make other material adjustments before shooting the panel. Adjust placement equipment to attain a smooth, controllable nozzle flow that is free of slugging or air bursts. Due to the panel's size, steady filling, free of irregular, high-energy bursts of material, is crucial to producing a test specimen that is properly consolidated. Initially, come close and direct the nozzle flow into the lower corners and then build from the bottom. When shooting wet-mix shotcrete with a coarse aggregate, use a blow pipe to keep the receiving surface free of rebound or loose sand. As the panel fills, back away slowly to keep excess energy from disturbing previously placed material within the panel until it reaches its full thickness (refer to Fig. 2 and 3).

If a nozzleman is unsure of the placement quality of material within a panel, it should be cleaned out and shot again.

After placement, do not trowel, sweep, or otherwise work the shotcrete surface. Movement by troweling can bring water to the surface or disturb the test panel's compaction and consolidation. Never allow panels to be worked, troweled, or finished. This unnecessary step can affect strength values. Specifications require that after panels are cored, ends of the cores will be prepared for uniformity by the testing facility.

Next Step: Do Not Disturb

Moving a freshly placed test panel will never increase its strength; however, it can certainly diminish it. Like any concrete, freshly placed test panels are extremely susceptible to damage from

external sources. Movement or large temperature fluctuations will influence panel integrity. Early-age shotcrete has not developed sufficient strength to withstand handling or thermal stresses during the first 24 hours or more. Test panels should always be positioned and shot in a location where they can remain *undisturbed and protected from the elements* for 24 hours or more.

Moisture's Influence on the Test Panel

Shotcrete does not harden by drying; it hardens by a complex chemical reaction called hydration. Moisture is required for the hydration process to occur. With time, shotcrete will grow progressively stronger if sufficient moisture is available for hydration (refer to Fig. 4). If internal concrete moisture drops to below roughly 80%, hydration will stop and concrete will no longer continue to gain strength.

ACI and ASTM specifications require that "The test panel shall be kept moist and at 70 ± 10°F (21 ± 5°C) until moved to test laboratory. The panels shall be covered and tightly wrapped (as soon after fabrication as is safe to prevent damage) with a sheet of material to prevent evaporation of water from the material."

Test panels left unprotected are subject to excessive moisture loss that can disrupt hydration and slow strength development. Low or erratic test values can occur anytime exposure allows panels to lose a significant amount of moisture. Curing practices implemented by the nozzleman and placement crew are crucial to the strength development of shotcrete test specimens.

After test panels are moved to a testing facility, they are stored under carefully controlled conditions within a "moist cabinet or room." Specifications require a temperature of 70 to 77°F (21 to 25°C) and a relative humidity of not less than 95% be maintained to diminish curing variables that may reduce strength development during storage. Unfortunately, panels kept within ideal conditions at the lab will not reverse damage to the panel caused by improper handling or curing practices at the job site during the critical initial hours.

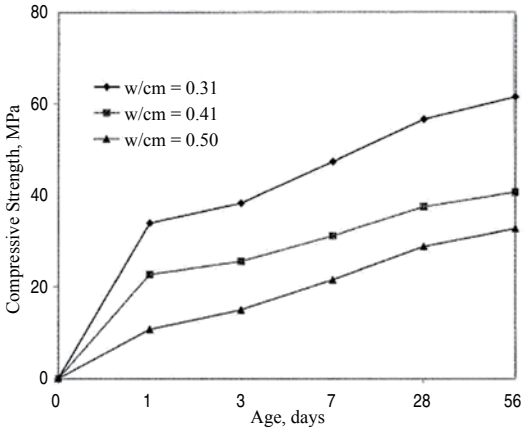

Fig. 4: Development of compressive strength of concrete with different w/cm *(RHA content = 10%) (Originally from Fig. 2-4 of ACI 232.1R-00 [Zhang and Malhotra]) (Note: 1 MPa = 145 psi)*

Summary

Actions of the nozzleman and shotcrete crew have a powerful influence on the strength development of specimens drawn from a shotcrete test panel. Training and education are required to diminish strength-test variables. A training program that draws attention to approved methods of creating, handling, and the proper care of shotcrete test panels is absolutely necessary to attaining representative strength values. Using techniques that assure a repeatable standard of care for each test panel should be a component of every shotcrete worker's education program.

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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 processes. 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.*

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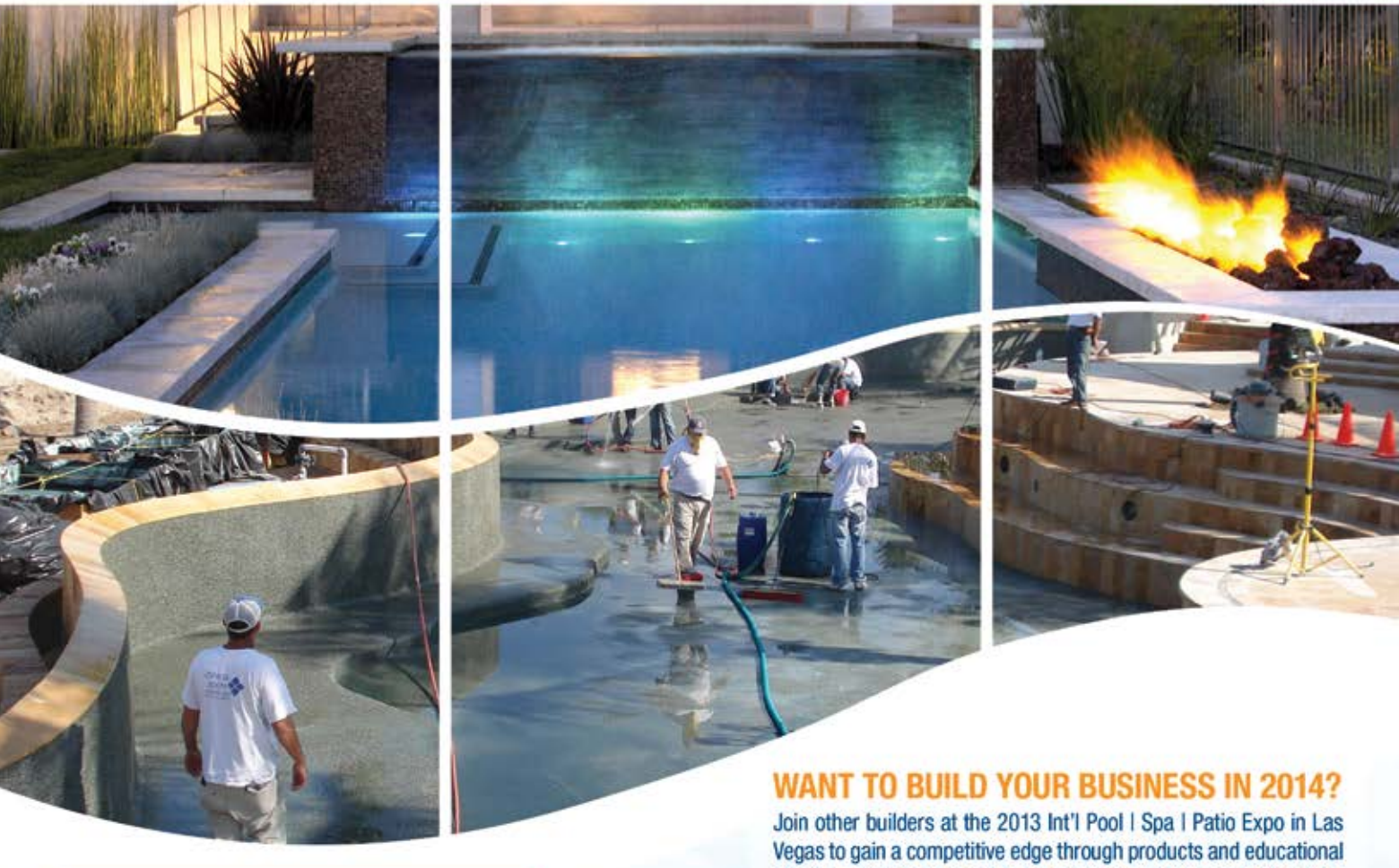

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Communication Is Key to Job-Site Safety

By Cathy Burkert

You know that saying, "What you don't know can't hurt you?" Guess what? IT CAN! Good communication is vital when it comes to job-site safety, productivity, and accident prevention. One of my all-time favorite sayings in my daily crew talks is "Communication is key to any successful relationship."

There are two ways to communicate: verbally and nonverbally. An example of effective verbal communication to employees is conducting toolbox talks. Gather your crew around before, during, or after the work shift or during a break, and then make everyone aware of the potential safety hazards for the day's operations. This is also a chance to let your field team know the goals for the day and to motivate them; but, in turn, keep them focused on the importance of job-site safety. In the toolbox meetings, it is important to communicate and document upcoming changes in the project and identify specific hazards that may arise with the changing work conditions.

When shotcrete is being placed, the use of earplugs or earmuffs often prevents personnel from using vocal communication between team members. Thus, in a high-noise environment, hand signals can be the most effective method of communication among the shotcrete crew. Use the toolbox talks to explain various hand signals and other forms of nonverbal communication that should be used throughout the day. As a construction team performs its work, it is important for team members to communicate with each other, especially if they see something that another crew member may not. In the shotcrete work environment, this necessitates the use of both verbal and nonverbal communication.

Another crucial part of communication is active listening. Active listening is not only "hearing" what your employees are saying but also taking the time to understand what they are actually communicating. It is crucial that your employees know that you are willing to listen to their input and suggestions, particularly when it comes to safety; it is everyone's job to take note of job-site hazards and point them out, especially ones that you may have missed. It is vitally important for teams to communicate with each other if they see a potentially unsafe condition. Ask for feedback to ensure everyone understands what you are trying to express, and let them offer suggestions on how to improve overall job-site safety. When a crew member reports or remedies a potentially unsafe condition, be sure to give them a big pat on the back in your next toolbox meeting in front

Fig. 1: Noisy job-site conditions can sometimes reduce effective communication

Fig. 2: Job-site meetings or toolbox talks are critical to informing workers of potential safety hazards

of the rest of the crew. This exemplifies that safety is everyone's job during a project. Finally, have them sign the toolbox talk worksheet to acknowledge they were actively involved in the safety process.

Safety can also be communicated indirectly in several forms. Safety signs or posters prominently posted around the job site can serve as constant reminders of the importance of safety. Keep the signs and posters clean and regularly replace or move them around the site so they are fresh and noticeable to the crew. A tattered safety sign that is covered in shotcrete overspray or dirt and barely legible doesn't convey the attitude that safety is a top priority. Keeping a clean, neat, and well-organized job site can also indirectly communicate an attitude that the working environment is important to both productivity and safety.

Remember, a good coach does not simply throw his starters into the game and wish them luck. It is YOUR job as a good coach to guide, teach, motivate, and listen to them and clearly and directly express to them the importance of safety.

Fig. 3: Pre-job toolbox talks should identify daily risks. Inform workers of the safe operation and use of required tools, such as job-specific scaffolding, before work commences

***Cathy Burkert** received her bachelor's degree in business management and thereafter started working at American Concrete Restorations, a Chicago-based shotcrete contractor. She joined the laborers' apprenticeship program to learn the intricate details of the trade. After 2 years in the program, she began running her own shotcrete crews and shortly thereafter earned the title of Field Office Coordinator. In March 2009, Burkert became the first female ACI Certified Nozzleman for the wet-mix, vertical, and overhead processes. She has been involved with two award-winning ASA infrastructure projects: the Abraham Lincoln Memorial Bridge in 2008 and the Dan Ryan Expressway in 2009.*

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Pool & Recreational Shotcrete Corner

The ASA Pool & Recreational Shotcrete Committee is again proud to announce the establishment of its third position statement: "Sustainability of Shotcrete in the Pool Industry." ASA recognizes the impact of sustainable structures built in the workplace today. Many in the design community look for alternative green construction techniques that have positive effects on the gathering and use of natural resources. The shotcrete industry's use of sustainable work processes goes hand in hand with this initiative. The Pool & Recreational Shotcrete Committee created this paper as a tool to aid pool builders with these techniques. Shotcrete contractors can continue to be part of the solution when it comes to green building techniques, which in turn helps with LEED Certification.

I would like to recognize Charles Hanskat, ASA *Shotcrete* magazine Technical Editor, Pool & Recreational Shotcrete Committee member, and Chair of the Sustainability Committee, for his efforts in this statement. Charles's contributions to our group as editor, content contributor, and overall lead in shotcrete sustainability are unmatched within ASA or ACI.

The continuing goal of the Pool & Recreational Shotcrete committee is to help pool builders who work with shotcrete identify proper applications and methodology. This paper can be found online at **www.shotcrete.org/poolpositionpaper_3**. Add this to your growing number of pool reference materials.

William T. Drakeley
Chair, Pool & Recreational Shotcrete Committee

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American Shotcrete Association's
Pool & Recreational Shotcrete Committee
Position Statement #3

AMERICAN SHOTCRETE ASSOCIATION

Sustainability of Shotcrete in the Pool Industry

Fig. 1: Lightweight, one-sided form is all that's needed when using shotcrete

Fig. 2: Pool shell is in place. Ready for the pool deck

Quality pool construction allows no compromise on the quality of materials or installation procedures. Fortunately, quality pool design and construction can also enhance the sustainability of both the installation and the finished product. The American Shotcrete Association (ASA) is attentive to the global need to promote green practices in all areas of shotcrete application. The pool industry has a great opportunity to provide enhanced sustainability through use of shotcrete construction.

The United States Green Concrete Council (USGCC) highlighted the "Top Ten" sustainability benefits inherent with shotcrete in its publication *The Sustainable Concrete Guide—Applications*. The ASA Pool and Recreational Shotcrete Committee confirms that eight of the 10 sustainability benefits directly apply to the creation of quality pool structures with shotcrete. The applicable sustainability benefits are:

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. Labor savings of at least 50% in repair applications.
5. New construction speed savings of 33 to 50%.
6. Better bonding to the substrate enhances durability.
7. Adaptability to repair surfaces that are not cost-effective with other processes.
8. Ability to access restricted space and difficult-to-reach areas, including overhead and underground.

Formwork savings of 50 to 100% over conventional cast-in-place construction

Pool shotcrete placement uses earth forms, wood, or any other immovable type of substrate to create the basic pool shape. Because shotcrete is placed at a 90-degree angle within 2 to 6 ft (0.6 to 1.8 m) of the receiving surface, it requires an open-faced or one-sided form system. Shotcrete is self-supporting in its plastic state and thus only requires one-sided forms to provide shape. This 50% reduction in materials, when compared to double-sided needed by cast concrete, provides substantial cost reduction in the overall pool construction (refer to Fig. 1 and 2).

Formwork does not have to be designed for internal pressures

As mentioned previously, fresh shotcrete is self-supporting and does not flow like cast-in-place concrete. Thus, the shotcrete process has little to no lateral pressure on the form from fluid pressure. This is true regardless of shooting a pool wall, spa, bench, or radius connection between the floor and vertical wall. The only pressure on the exterior form during the shooting process is the momentary impact pressure from the shotcrete placed at high velocity by air volume.

Complex shapes require very little—if any—formwork

The pool industry—particularly, when using the shotcrete process—epitomizes this statement. Free-form shapes, vanishing-edge perimeters, raised spa elevations, skateboard parks, and any monolithic nonplanar concrete structure envisioned by the designer eliminates the need for complex forming through using shotcrete (refer to Fig. 3 and 4).

Labor savings of at least 50% in repair applications

Typically, while repairing an older pool with deteriorated or spalled concrete, the poor material is removed to expose a reusable, hard, quality concrete surface where renovation materials can be placed (otherwise, the whole pool is removed). In this type of renovation, the expediency and rapidity of placing the repair material through the shotcrete process is much more cost-effective than forming and pouring a cast-in-place repair. Using shotcrete, there are labor savings in eliminating form placement and stripping, the need for a bonding agent, and placing and consolidating cast concrete.

New construction speed savings of 33 to 50%

The overall time of installation and implicit costs associated with the speed of installing a concrete pool shell using the shotcrete process versus using cast-in-place methods is significant. Quite simply, it takes 33 to 50% less time to build the same size pool structure with shotcrete compared to cast-in-place methods. Excavation, forming, reinforcing steel work, and concrete placement need less time to complete because of the one-sided forming aspect and use of the surrounding earth as part of the support structure, as well as requiring less labor force to complete each phase.

Better bonding to the substrate enhances durability

Concrete placement through the shotcrete process is the ideal way to place concrete, and when done properly, will yield high concrete strengths. Not only is the high-strength shotcrete durable but it is also watertight with good impact resistance, which enables it to withstand accidental loadings that could compromise the structure. Shotcrete inherently has superior bonding of the concrete to a properly prepared substrate. The high velocity at which the material is placed ensures that the open pores or crevices of the receiving substrate will have cement paste driven into and covering the surface area. Additionally, shotcrete's impact velocity on the receiving surface acts as a natural surface roughener that further enhances bond. Combined, these effects ensure proper bond and makes

Fig. 3: Overview of a pool with extensive curves typifying shotcrete's flexibility

Fig. 4: Using shotcrete makes curved concrete pool surfaces easy

shotcrete the ideal method for ensuring long-lasting concrete that will require minimum repair and/or replacement.

Adaptability to repair surfaces that are not cost-effective with other processes

In pool repairs, the adaptability benefits of shotcrete are a result of the simple fact that one does not require significant forming. Shotcrete is bondable to every masonry material used in the pool industry and can be shaped in any free-form style used for water flow.

Ability to access restricted space and difficult-to-reach areas, including overhead and underground

Again, as mentioned previously, shotcrete can be placed more easily in a pool environment than can cast-in-place concrete. By using the shotcrete pumping system with its flexible hose connections in either the dry or wet process, one can get the nozzle at the right distance in any area of the project (for example, deep diving wells, raised waterfalls, and perimeter overflows). This reduces costs of conveying the material on-site, labor, and placement because of the flexibility of the shotcrete hose, leading to less waste and more efficient installation.

In conclusion, the shotcrete process, when implemented correctly for swimming pool or recreational construction, is inherently sustainable. In particular, the sustainability of the shotcrete process and the portion of the pool industry that uses it for pool installation is drawn from three main factors: 1) one-sided forming and the direct savings in material and labor costs; 2) the overall strength, enhanced durability, and superior bond of the final shotcrete pool sections that will require fewer, if any, repairs and have a longer life; and 3) the flexibility of shotcrete as the optimal process for repair and renovations of existing structures. Overall, shotcrete in the pool industry uses less energy, less money, and less material while providing placement of better-quality concrete.

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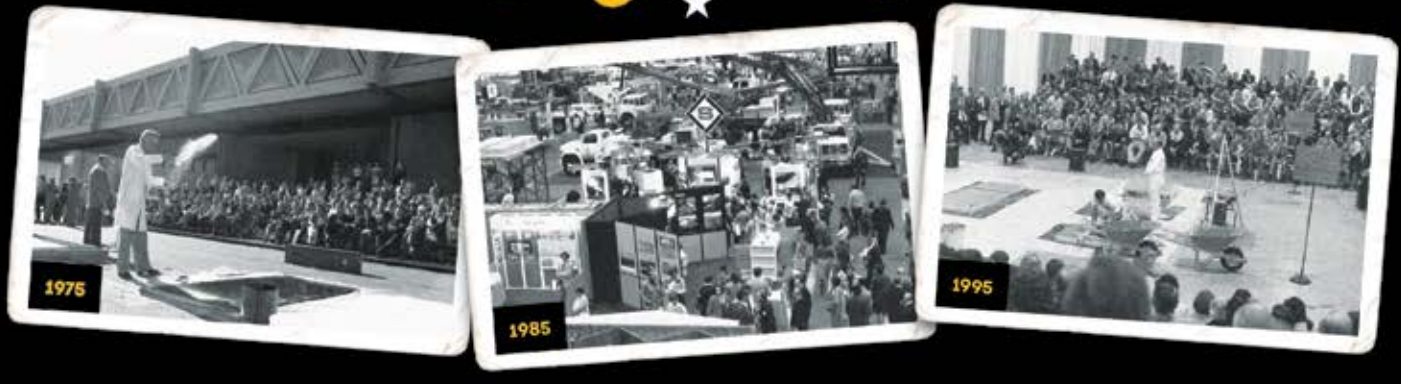

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Top Ten Sustainability Benefits of Shotcrete

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

U.S. GREEN CONCRETE COUNCIL

1. Formwork savings of 50 to 100% over conventional cast-in-place construction.
2. Formwork does not have to be designed for internal pressures.
3. Complex shapes require very little—if any—formwork.
4. Crane and other equipment savings or elimination.
5. Labor savings of at least 50% in repair applications.
6. New construction speed savings of 33 to 50%.
7. Speed of repair reduces or eliminates downtime.
8. Better bonding to the substrate enhances durability.
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** (see below).

Ability to Access Restricted Space and Difficult-to-Reach Areas, Including Overhead and Underground

Accessing the site of a concrete pour can often be one of the biggest challenges faced by contractors. Good quality, pumpable concrete mixtures will help minimize the extent of the challenge. But, in the case of form-and-pump placement, forming crews will still be required to install forms and remove them after placement. The extent of the challenges can be magnified when accessing difficult-to-reach locations, such as an elevated bridge structure or a location deep underground in a mine or tunnel. These challenges can often be minimized when shotcrete is the placement method chosen.

The reduction or elimination of formwork minimizes movement of materials, a key benefit provided by the shotcrete process. In difficult-to-access locations, a shotcrete nozzleman can place concrete thousands of feet (1000 ft = 300 m) away from the material source, and is limited only by the amount of available air required to move the material for dry-mix applications and the pump selection in wet-mix applications.

When faced with the challenge of difficult access, it is important for specifiers to have a strong understanding of the capabilities and limitations of the shotcrete placement process. Understanding these capabilities and limitations will allow them to specify shotcrete for applications where conventional form-and-pump placement methods are difficult and costly to undertake.

Dry-Mix Shotcrete Process

When placing dry-mix shotcrete, the concrete mixture is pneumatically conveyed through a shotcrete hose or other conveying pipe until it reaches the nozzle, where the water required for hydration is added by the nozzleman. The benefits in terms of access are obvious. The distance that a dry concrete mixture can be conveyed is dependent on a number of factors—the most important being volume of air. A minimum of 185 ft^3/m (5.25 m^3/m) is usually required to convey a dry shotcrete mixture a distance of 100 ft (30 m), allowing the shotcrete nozzleman to access elevated locations such as a bridge deck or confined spaces such as a sewer pipe, while the remainder of the crew's material and equipment are staged at

an easier-to-access location. If higher volumes of air (and longer hose lengths) are available, the distance over which the shotcrete can be conveyed can be much greater.

Wet-Mix Shotcrete Process

When placing wet-mix shotcrete, the concrete mixture (with water already added) is pumped through a hose and air is added at the nozzle to increase the speed of the mixture to achieve a high velocity. Benefits in terms of access are the same as those experienced when using dry-mix shotcrete. The distance that wet-mix shotcrete can be pumped is dependent on the capabilities of the concrete pump and, of course, the available length of the hose. One important difference between the two placement methods is the weight of the hose. In the dry-mix shotcrete process, much of the material composition (as it travels through the hose) consists of air. In the wet-mix shotcrete process, the material composition also contains admixtures and the water required for hydration. The result is a much heavier material hose that is more difficult to maneuver.

Access in Underground Environments

Difficult access is a common challenge when placing concrete in an underground environment. In mining environments, concrete placement is often required in locations that are extremely difficult to reach (refer to Fig. 1). One example would be ore bins that often require concrete lining; or shafts and raises that require stabilization. A nozzleman can usually access a raise (often from a working platform) hundreds of feet (100 ft = 30 m) above the access point where concrete can be placed using either the dry or wet shotcrete process. Both processes have challenges that are common to many underground environments—the most common being communication between the nozzleman and the gun/pump operator.

It is imperative from a safety standpoint that communication between the nozzleman and the gun/pump operator always be maintained. A constant line of communication is critical to ensure that the material flow is cut off in the event of a plug or an injury. It should be noted, however, that in the case of underground environments, visible contact is not always possible and must be substituted with verbal communication, usually through the use of voice-activated headsets.

For an application in which dry-mix shotcrete material is conveyed vertically over significant distances, consideration should also be given to the available water pressure. Although the volume of air may be sufficient to convey the material to a waiting nozzleman, the water pressure must also be sufficient to ensure the mixing water also reaches the nozzle. This can be of particular concern in a confined space where lack of water at the nozzle would result in dry, cementitious material filling the space. This provides another example of the importance of communication between the nozzleman and the gun operator.

When shotcrete equipment is located above the placement site and the shotcrete material is conveyed down hundreds of feet (100 ft = 30 m) into a raise or ore bin, the increased velocity of the material can often lead to inconsistent material flow and hose blockages. Depending on the process (wet or dry), there are a number of steps that can be taken to minimize the effect of gravity on the material conveyed down to the point of placement. First, the hose can be "looped" to decrease the velocity of the material prior to it exiting the nozzle and to help balance the speed of the material. This is especially true in the dry-mix process when combined with a decrease in conveyance air, as required.

Although the effect of gravity must be monitored closely in the dry-mix process, the wet-mix process is more susceptible to hose blockages and nozzle pulsation due to the force of gravity on the material within the pipeline. As the conveying hose or pipe is filled, segregation can occur as the material enters free-fall, and a plug can arise before shooting begins. The use of a sponge ball or "Go Devil" can eliminate plugs caused by segregation, as this ball restricts material flow and forces the concrete pump to naturally convey material through the line. As with the dry-mix process, a "loop" in the hose or the addition of an elbow (configured similarly to a "P Trap" under a sink) can help to regulate material flow and allow the pump to convey material, instead of gravity conveying the material. For this reason, it is often easier to convey concrete up, rather than down, especially when the conveying distance is in excess of 100 ft (30 m).

Access in Elevated Environments

The rehabilitation of elevated bridge structures is a common example of an application where the shotcrete process can minimize the problems related to access (refer to Fig. 2). Once deteriorated concrete is removed, it must be replaced to ensure structural integrity. On elevated structures, especially over water, railways, or heavy traffic areas, it can be extremely challenging to access the areas where concrete placement is required (refer to Fig. 3). In a form-and-pump application, forms and form hardware must be lifted into place and removed several days later, after the concrete reaches sufficient strength. This can be an arduous task,

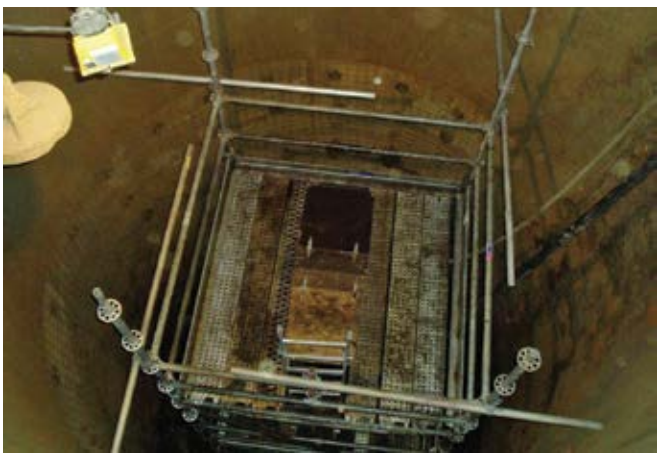


Fig. 1: In mining environments, concrete placement is often required in locations that are extremely difficult to reach, such as ore bins

especially when several patches throughout the structure require repair. Through the use of the shotcrete process, a nozzleman and finisher can shoot, cut, finish, and cure several patches in succession, without having to return to the same location on the structure. This results in lower labor costs and a reduced construction schedule. The shotcrete process also allows the contractor to stage materials and equipment from one central location, accessing several repair areas from that location, thereby minimizing movement, planning, and time necessary to shift operations.

Access in Remote or Isolated Environments

Concrete placement challenges can also come from projects where access to the project itself is the biggest challenge. Repairs to an isolated lighthouse and construction of a remote dam are two examples. For these types of projects, a lack of proximity to a batch plant, cement supply, and aggregate source generally makes pre-blended, pre-bagged materials the best choice for material supply. As with other projects where access is a challenge, the less formwork required, the more efficient the concrete placement process will be. When the Haut-fond Prince Lighthouse rehabilitation was tendered in 1996, shotcrete was specified as the placement method and a highly accelerated, durable, steel-fiber shotcrete mixture, supplied in lined marine tote bags, was specified for the material supply (refer to Fig. 4). The site was located in the middle of the St. Lawrence River, 5 miles (8 km) from the coast of Tadoussac, QC, Canada, and was only accessible by barge and only when the weather was cooperative. Shotcrete nozzlemen worked from an inflatable zodiac, with all material, equipment, potable water, and other personnel located on the main barge. The shotcrete was placed ahead of the rising tides through a 490 ft (149 m) long hose that ran from the barge to the zodiac. The shotcrete process allowed easier access to the site and eliminated any need for forms. It played a significant role in the successful completion of this project.

Access in Challenging Terrains

Whether selecting a wet or dry shotcrete process, it is much easier for a nozzleman to reach a difficult-to-access placement site while the crew, material, and equipment are stationed in an accessible location. Difficult access, however, can mean different things to different people. The location of a backyard swimming pool, for example, can be considered a difficult-to-access location for the pumps and other materials supply equipment. Other examples of difficult access can be much more extreme and include projects that require skilled nozzlemen who are also skilled rock climbers.

An example of the latter occurred in 2003, when New Jersey Transit was faced with the challenge of stabilizing the rock

Fig. 2: The rehabilitation of elevated bridge structures is a common example of an application where the shotcrete process can minimize the problems related to access

Fig. 3: On elevated structures, forms and form hardware must be lifted into place and removed several days later

face of the King's Bluff Slope and Weehawken Tunnel East Portal along the Hudson-Bergen Light Rail Transit Line (refer to Fig. 5). Shotcrete crews from Atlantic Underground Services Ltd. (AUSL) of Riverview, NB, Canada, were contracted to place up to 4 in. (101 mm) of steel fiber-reinforced, dry-mix shotcrete over a rock face situated up to 200 ft (61 m) above the rail line. In addition to being skilled in the art of dry-mix shotcrete placement, the AUSL nozzlemen had also mastered the skill of rappelling down rock faces (refer to Fig. 6). This skill allowed the AUSL nozzlemen to place over 236 yd^3 (181 m^3) of material over a period of several weeks, while the remainder of the crew handled the material delivery and equipment operation at the base of the bluff.

Accessibility is a key factor when choosing which concrete placement method is best suited for a specific application. On projects where access is difficult, the traditional form-and-pour school of thought will often leave contractors with challenges that are difficult and costly to overcome. The benefits offered by shotcrete will provide specifiers with an effective alternative that is less labor-intensive, more sustainable, and less costly.

Fig. 4: Shotcrete was specified as the concrete placement method for the rehabilitation of the Haut-fond Prince Lighthouse in the St. Lawrence River

Fig. 5: New Jersey Transit was faced with the challenge of stabilizing the rock face of the King's Bluff Slope

Fig. 6: In addition to being skilled in the art of dry-mix shotcrete placement, the AUSL nozzlemen had also mastered the skill of rappelling down rock faces

Superior Gunite Company Johnson Western Gunite Company

Superior Gunite and Johnson Western Gunite have roots going back to the 1930s and are known throughout the United States as a premier shotcrete/gunite contracting firm. The team has accomplished very challenging projects throughout the United States from tunnels and dams to structural walls in buildings. The companies have rehabilitated and rebuilt dry docks, railroad and highway tunnels, unreinforced and under-reinforced buildings, bridges, and many other concrete or masonry structures. They regularly construct new retaining walls, commercial building basements, structural walls in buildings, pipe linings, tunnel linings, canals, reservoirs, and spillways for dams.

The companies were instrumental in the development and improvement of the wet-mix shotcrete process and continue to innovate and apply shotcrete in new areas. Most of their work is originally specified as cast-in-place concrete that is then value-engineered into shotcrete projects.

Some recent notable projects include below-grade walls at the World Trade Center, NY; structural shotcrete on the East Side Access Project, NY; all vertical concrete walls on the California Memorial Stadium, Berkeley, CA; demolition, rock bolting, and shotcrete for the Norfolk Southern Railroad for the Heartland Corridor Project in VA and WV; basement walls for LA Live in Los Angeles, CA; and primary shotcrete lining for the new bore of the Caldecott Tunnel, CA.

The most recent addition to the companies' capabilities is providing pipe rehabilitation through the use of UV CIPP and spin lining with corrosion and sewer-gas-resistant materials.

Their guiding principles are quality, safety, and productivity. They strive to be the "go-to shotcrete companies" for all of their customers. Their customers know that if a project involves critical scheduling or quality issues, Superior Gunite/ Johnson Western Gunite can fill their needs.

Cal Memorial Stadium, Berkeley, CA: Seismic strengthening of existing historic curved wall

East Side Access, New York, NY: Elevator inclined shaft final lining for tunnel

Superior Gunite / Johnson Western Gunite Company

940 Doolittle Dr
San Leandro, CA 94577-1021
Website: www.shotcrete.com
Contact: Larry J. Totten
E-mail: larryt@jwgunite.com

AMERICAN SHOTCRETE ASSOCIATION
ONLINE BUYERS GUIDE

Online tool offers the industry free access to products and services of the leading companies in the shotcrete industry

The American Shotcrete Association (ASA) Buyers Guide is now available free to the concrete industry at **www.shotcrete.org**. Look for "Buyers Guide" in the "Products/Services & Information" section.

The ASA Buyer's Guide provides an important tool to locate those companies that continually prove their commitment to the shotcrete process and its quality by supporting ASA through Corporate Membership.

This service enables users to search for companies based on products and/or services related to shotcrete across seven main categories:

- Admixtures
- Cement/Pozzolanic Materials
- Consulting
- Contractors
- Equipment
- Fibers
- Shotcrete Materials/Mixtures

Searches can be further refined using over 100 subcategories and geographic criteria.

AMERICAN SHOTCRETE ASSOCIATION

www.shotcrete.org • (248) 848-3780

IMCYC's FIC 2013 Held in Mexico City

Foro Internacional del Concreto (FIC) (International Concrete Forum) 2013, "Challenges and Opportunities for Sustainable Concrete," took place in Mexico City, Mexico, at Centro Banamex on May 28-30, 2013.

The primary objective of the Instituto Mexicano del Cemento y del Concreto A.C. (IMCYC) during this 2013 event was to promote the continuing education of engineers, architects, designers, technicians, supervisors, constructors, developers, professors, and students by bringing them the most innovative topics concerning the latest research in materials, construction, technology, and international projects. A special emphasis was placed on the importance of quality control, sustainable practices, innovations, and the promotion of state-of-the-art technologies.

As in previous years, FIC 2013 continued to focus on a primary concern: sustainability. The goal was to present and promote new construction practices and materials that will allow the industry to better use resources, encourage innovative methods, and make use of the leading technologies that are mindful of the environment.

Lihe (John) Zhang, ASA Board member, was one of 31 speakers from the United States, Brazil, England, and Mexico invited to speak at this event. Julie Buffenbarger, FACI, Chair of ACI Committee 130, Sustainability of Concrete, was the keynote speaker. A total of about 250 attendees from Mexico, including Professors, Engineers, suppliers, contractors, and researchers, were present. It was a great opportunity for attendees to interact with the Mexican concrete industry and to witness how the country is actively placing shotcrete on many projects, particularly in the mining and tunneling industries.

Shotcrete/Sprayed Concrete Market Projected at $6.5 Billion by 2018

The report "Shotcrete/Sprayed Concrete Market by Process (Wet & Dry), Applications (Underground Construction, Water Retaining Structures, Protective Coatings, Repair Works & Others), Systems & Geography: Global Trends and Forecasts to 2018," defines and segments the global shotcrete market with analysis and forecasting of global revenue and consumption. It also identifies driving and restraining factors for the global shotcrete market with analysis of trends, opportunities, burning issues, and winning imperatives.

The market is segmented and consumption and revenue are forecasted on the basis of major regions such as North America, Europe, Asia-Pacific, and the rest of the world (ROW). The key countries are covered and forecasted for each region. Further, the market is segmented and revenue is forecasted on the basis of major types of shotcrete used in various industries, such as underground construction, water-retaining structures, protective coatings, repair works, and others.

The global market for shotcrete in terms of revenue was estimated to be worth $4.2 billion in 2012 and is expected to reach $6.5 billion by 2018, growing at a Compound Annual Growth Rate (CAGR) of 7.8% from 2013 to 2018. The European region dominated global shotcrete market revenue in 2012. Europe is expected to have the highest revenue by 2018, followed by the Asia-Pacific region. ROW is expected to be the next fastest-growing market, with a CAGR of 8.7% from 2013 to 2018, owing to rising consumption in this region where the end-user markets of shotcrete are growing steadily. The North American Market is expected to grow at a rate of 8.0% in revenue terms.

For the detailed report, visit **www.marketsandmarkets.com**.

Industry Personnel

IGHL Honors John Tortorella

Independent Group Home Living (IGHL) held its Annual Spring Gala this year honoring Southampton businessman **John Tortorella** of J.Tortorella Custom Gunite Swimming Pools and Sun Stream USA. Tortorella stated, "I am so proud and humbled to be a part of this great organization and to be this year's honoree.

It brings tears to my eyes when I think of the great work they do. It is truly amazing."


John Tortorella

IGHL is nationally recognized as the standard by which all service providers to people with developmental disabilities are measured. Founded shortly after 1972 by a group of concerned Long Islanders, IGHL has grown to include 75 facilities serving hundreds of men, women, and children with a staff of over 1500 dedicated caregivers. For more information, visit **www.ighl.org**.

ACI Announces New Officers for 2013

The American Concrete Institute (ACI) introduced its 2013-2014 President, Vice President, and four Board members during the ACI Spring 2013 Convention in Minneapolis, MN.


Anne M. Ellis

Anne M. Ellis, Vice President, Government Initiatives, AECOM, Springfield, VA, will serve as President of the Institute for 2013-2014. She succeeds James K. Wight, Professor of civil engineering at the University of Michigan in Ann Arbor, MI, who served as President of the Institute for 2012-2013.


Sharon L. Wood

Sharon L. Wood, the Robert L. Parker Sr. Centennial Professor of Engineering and Chair of the Department of Civil, Architectural, and Environmental Engineering at the University of Texas at Austin, Austin, TX, has been elected ACI Vice President for a 2-year term. **William E. Rushing Jr.**, Vice President with Waldemar S. Nelson & Co., Inc., in New Orleans, LA, 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 a 3-year term: **Dean A. Browning**, Project Director, Charles Pankow Foundation, Vancouver, WA; **Cary S. Kopczynski**, Senior Principal and CEO, Cary Copczynski & Co. Inc., Bellevue, WA; **Kevin A. MacDonald**, President and Principal, Beton Consulting Engineers LLC, Mendota Heights, MN; and **David M. Suchorski**, Senior Technical Services Manager/Sales Manager, Ash Grove Cement Company, Des Moines, IA.

Submit Your Project for ASA's Outstanding Shotcrete Project Awards

The Ninth Annual ASA Outstanding Shotcrete Project Awards are now open and projects can be submitted until **October 1, 2013**. These annual project awards recognize excellence and innovation in projects in which the application of shotcrete has played a significant role.

The ASA award program offers you and your organization unique and distinguished exposure within the shotcrete industry. In addition, the awards program and the annual awards issue of *Shotcrete* magazine are important tools used to inform and educate the construction world, providing an exciting real-world demonstration of the many benefits and advantages of placing concrete via the shotcrete process.

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

ASA Fall Committee Meetings in Phoenix, AZ, October 19, 2013

The ASA Fall 2013 Committee Meetings in Phoenix, AZ, will be held at the Hyatt Regency and Phoenix Convention Center on **Saturday, October 19, 2013**.

The following committees have scheduled working meetings: the ASA Executive Committee, Education Committee, Sustainability Committee, Pool & Recreational Committee, Safety Committee, Publications Committee, Marketing & Membership Committee, Underground Committee, and ASA Board of Direction. These meetings offer participants the opportunity to network with colleagues, provide input on shotcrete materials and publications, and take part in ASA's overall mission.

The ASA committee meetings are held in conjunction with the ACI Fall 2013 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/pages/news-events/calendar.htm**.

Now Accepting ASA Graduate Scholarship Applications

ASA is now accepting applications for Graduate Scholarships for the 2013 to 2014 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 in the United States, and a second scholarship will be awarded to a graduate student attending an accredited college or university in Canada.

Based on essays, submitted data, and references, the ASA Scholarship Committee will select scholarship recipients who have the strongest combination of interest and potential for professional success in the shotcrete industry. Each ASA Graduate Scholarship Award consists of a $3000 (USD) stipend, which is paid in one installment directly to the student's educational institution.

Applications and all required documents must be received by 5:00 p.m. (EST) on **November 1, 2013**. All application information and requirements can be found at **www.shotcrete.org/pages/education-certification/grad-scholarships.htm**.

ASA Board Appoints Guarino and Bridger as Directors

Mason Guarino

Patrick Bridger

At its spring 2013 committee meeting in Minneapolis, MN, the ASA Board of Direction addressed a vacancy by confirming the nomination of **Mason Guarino**, of South Shore Gunite Pool & Spa, Inc., as a Director. Guarino will serve as Director for the remainder of a term that ends in 2014. ASA welcomes Guarino in this new position.

Having unfortunately lost Edwin Brady, a very highly respected member, the Board of Direction has also recently confirmed the nomination of **Patrick Bridger**, of Putzmeister Shotcrete Technology, as a Director. Bridger will serve as Director for the remainder of Brady's term, which will end in 2015. Bridger is a Past President, previous Board member, and long-time member of ASA. The association welcomes him back to this position.

Upcoming ASA Nozzleman Education Sessions Offered

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

ASA Nozzleman Education Sessions present an overview on placement technique, finishing, curing, testing, equipment, and safety as it relates to the nozzleman and the shotcrete process. ASA Nozzelman Education Sessions also prepare individuals to participate in the ACI Shotcrete Nozzleman Certification program.

Please note:

- Session attendance alone **will not** result in ACI Shotcrete Nozzleman Certification.

- This session **will** satisfy the education session requirement for a nozzleman 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 through ASA, which includes the ACI written and performance examinations.
- Attendees **will** qualify for and receive a complimentary 1-year ASA Nozzleman membership.
- ACI CP-60 (09), "Craftsman Workbook for ACI Certification of Shotcrete Nozzleman," is included with the session registration fee.
- Supervisors, Project Managers, and Foremen who do not intend to pursue certification are also encouraged to attend to better understand the process in order to guide their crew.

The ASA Nozzleman Education Sessions will be offered in the near future at two locations:

1. **2013 International Pool | Spa | Patio Expo**
   November 12-13, 2013, Las Vegas, NV

INTERNATIONAL POOL | SPA | PATIO EXPO
THE BACKYARD EXPERIENCE
hanley wood SPONSORED BY APSP

This ASA Nozzleman Education Session will span 2 days: **Tuesday, November 12, from 3:00 p.m. to 6:00 p.m., and Wednesday, November 13, from 8:00 a.m. to 12:00 p.m.** The course will be instructed by William Drakeley, ASA Board member, ASA Pool & Recreational Shotcrete Committee Chair, ACI Examiner, and ACI Certified Nozzleman.

This is a Level 300 course that offers seven technical credit hours. The individual registration fee prior to September 20, 2013, is $259 (USD), which thereafter increases to $345 (USD). The fee includes study materials provided by ASA.

For more information and to register for this session, visit **www.poolspapatio.com** or the ASA calendar at **www.shotcrete.org/pages/news-events/calendar.htm**.

2. **2014 World of Concrete**
   January 2014, Las Vegas, NV

WORLD OF CONCRETE®
WORLD OF MASONRY | TECHNOLOGY FOR CONSTRUCTION
hanley wood

As of this printing, specific dates, times, and registration fees are not yet finalized. Please visit the calendar on the ASA website at **www.shotcrete.org/pages/news-events/calendar.htm** for details.

ASA at the 30th Anniversary International Bridge Conference

ASA recently exhibited at the Engineers' Society of Western Pennsylvania's 30th Anniversary International Bridge Conference in Pittsburgh, PA. Viewed as the preeminent arena for the bridge industry in North America, Europe, and Asia, this event attracted bridge owners and engineers, designers, construction executives, suppliers, government officials, and policy makers from throughout the United States and abroad.

The staff was assisted by ASA Vice President Charles Hanskat to interface with attendees and answer specific technical inquiries about specifying shotcrete. The booth also featured a video demonstration of the shotcrete method in a variety of applications, as well as many free publications on specifying shotcrete for the construction and rehabilitation of new and existing structures.

Shotcrete FAQs

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

Question: *I need to specify a shotcrete cover to some structural steel in a coal dump hopper. The idea is to provide abrasion and impact protection to the steel beams. However, the client cannot afford to have the hopper out of service for an extended period. Is there a "high-early-" strength option for shotcrete as there is for cast-in-place concrete?*

Answer: There are prepackaged materials commercially available for impact and abrasion resistance. Please contact material suppliers from "ASA's Buyers Guide" for product information: **www.shotcrete.org/pages/products-services/Buyers-Guide/index.asp**.

Question: *Is it critical for the early and intermediate compressive strength at 3 and 7 days, respectively, to be met for shotcrete applications for a rock fall face if the 28-day compressive strength is met?*

Answer: Compressive strength at 1, 3, and 7 days can be important to all for subsequent operations. In general, 7-day strengths are a good indicator of the ultimate 28-day strength. The need for early strength is an engineering and construction sequence issue, not a normal or typical shotcrete requirement.

Question: *Can you send me a document with ASA specifications for gunite coverage of reinforcing bar for swimming pools, please?*

Answer: ASA does not have such a document. The concrete cover for embedded reinforcing steel is subject to the local Building Codes and may be increased by the structural plans and specifications produced by an Engineer or Architect for a specific project. ACI 350-06, "Code Requirements for Environmental Engineering Concrete Structures and Commentary," covers concrete structures intended for water containment and would be applicable to pools. The following is a link to ACI's bookstore: **www.concrete.org/BookstoreNet/ProductDetail.aspx?itemid=35006**.

Question: *I would appreciate if you could comment on a city of Los Angeles shotcrete code that requires that shotcrete lifts*

not exceed 3 ft (1 m) and that 3 hours must pass before the second lift can be applied.

First of all, if you waited 3 hours between lifts, you would have full-length cold joints along the whole length of the wall. You'd also have to wash out the pump after every lift or the concrete would harden in the pump and hoses. Second, you can't leave a 4000 to 5000 psi (28 to 34 MPa) mixture sitting in the truck for 3 hours! Does it make any sense to you?

Answer: This provision has been an issue for shotcrete contractors in the region for many years. ASA and ACI Committee 506, Shotcrete, do not endorse the concept stated in the "Los Angeles Bulletin." Unfortunately, this provision has shown up in other areas around the country.

A good shotcrete practice is to limit lift height to that which can be placed without sloughing or sagging and to place subsequent lifts at such a time that the previous lift is sufficiently firm to support the subsequent lift. ACI 506R-05, "Guide to Shotcrete," Section 8.5.8, specifically addresses this point. The following is a link to ASA's bookstore: **http://shotcrete.org/BookstoreNet/ProductDetail.aspx?itemid=506R-05**.

Question: *I am a Civil Engineer working on a hydropower project. Is it possible to place shotcrete at a thickness of 24 in. (600 mm) inside a tunnel that will be used as a water tunnel to generate power?*

Answer: Yes, it is possible to shoot 24 in. (600 mm) thick tunnel linings. There are various ways of doing this, depending on the reinforcing steel configuration. One method we have successfully used for shooting tunnel linings this thick with a double mat of reinforcing bar (1 in. [20 mm] diameter bars at 6 in. [150 mm] on center, vertically and horizontally) is to bench gun shoot the walls up to the spring line with a wet-mix silica-fume-modified shotcrete (without accelerator) and then ribbon-shoot (2 ft [0.5 m] wide strips) overhead using the same mixture but with the option of using an alkali-free accelerator added at the nozzle.

If the shotcrete requires a smooth finish (equivalent to a cast-in-place concrete finish), then the initial shotcrete is shot to within about 1 in. (30 mm) of the final shotcrete thickness and allowed to set and harden. Following that, a final non-accelerated finish coat can be applied that can be trimmed to shooting wires with a cutting rod, closed up with a darby, and then trowelled with either a magnesium or steel trowel, depending on the required finished surface texture.

Such work can be done with a remote-control manipulator arm (robot) or, for more precision, with hand nozzling out of a basket on a manlift (provided the tunnel floor is sufficiently

smooth for operation of a manlift). The bottom line: hire a contractor who has experience in conducting such work.

Question: *I would like to know the standard operating procedures for cleaning out shotcrete hoses with air and/or water and, in particular, how to keep the hose from whipping when using air.*

Answer: Shotcrete hoses can be cleaned out using either water or air. In many instances, the site conditions make cleaning with water not feasible. When cleaning with air, the free end or discharge end of the hose should be secured to something to ensure that the hose does not whip as the material and cleaning ball or rag discharges.

Question: *We are working with an architect in New York City on an unreinforced masonry (URM) building where they want to remove brick to provide a larger storefront opening. I would like to use the remaining walls to resist lateral forces but the brick is insufficient. We would like to remove one width of brick and apply 4 in. (102 mm) of reinforced shotcrete in its place. Can you tell me where I can find applicable code and design guidelines for this application?*

Answer: Your proposed solution is certainly reasonable and is used regularly. Shotcrete has been used to strengthen both URM and tilt-up panels to accommodate enlarged openings. Shotcrete is a method of placing concrete and the in-place properties would be the same. The applicable code would be the code you would use if you were to strengthen this wall with concrete. Designs using the ACI 318 Building Code and Commentary are fully applicable to shotcrete placement, although compressive tests for acceptance are secured using cores from shotcrete test panels per ASTM C1140/C1140M and C1604/C1604M, rather than cast cylinders.

Question: *Is there a specification with regard to cold joints when using shotcrete?*

Answer: Generally, the interface between sequentially placed layers of shotcrete is not considered a cold joint because the shotcrete abrasion, velocity of impact, and high paste content make excellent bonding conditions. Cores taken through layers of shotcrete on shotcrete often show that it is virtually impossible to ascertain one layer of shotcrete from the next. Please refer to ACI 506R, "Guide to Shotcrete," for information on joints in shotcrete.

Question: *We are in the process of designing retaining walls that will be supported by either concrete piers or steel piles. We would like to see some typical details on how the reinforcing is secured to either the piers or piles.*

Answer: For concrete piers, the reinforcing steel is generally secured to the piles with reinforcing bar grouted dowels. For steel piles, the reinforcing bar is generally secured with Nelson studs.

Question: *I am evaluating a community in central Colorado that contains shotcrete slope reinforcement ranging from 14 to 44 ft (4 to 13 m) in height. Assuming the installation met all required guidelines, what should I anticipate as a useful life for this product?*

Answer: Shotcrete is a method of placing concrete and properly placed shotcrete should have a service life similar to cast concrete. Generally, concrete structures in normal environmental exposures are expected to have service lives from 50 to 100 years. With particular attention to materials and construction methods, some concrete structures, such as the new San Francisco Bay Bridge, have been designed for a service life up to 150 years. The first step in achieving a long-lasting, high-quality installation is to engage a highly qualified and experienced shotcrete contractor. There are many other factors that influence service life, including using the right mixture design for the anticipated exposure conditions.

Question: *Is there is a manufactured depth gauge that would be glued/nailed to the form to allow the nozzleman to physically see how much concrete is being applied to the surface? We have a condition where there will be two or three applications on the same surface, and I am concerned that the correct depth is not being applied in each pass.*

Answer: ACI 506R-05, "Guide to Shotcrete," Section 5.6, on Alignment Control (refer to ASA Bookstore: **http://shotcrete.org/BookstoreNet/ProductDetail.aspx?itemid=506R-05**) gives specific guidance on proven methods to establish the line and grade of the surface, as well as proper material thickness and cover. Common methods are use of ground wires, guide strips, depth gauges, and depth probes. Please refer to "ASA's Buyers Guide" (**http://shotcrete.org/pages/products-services/Buyers-Guide/index.asp**) and contact one of our members who provides supplies to the shotcrete industry.

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.*

King Packaged Materials Company Celebrates Boisbriand Plant Opening

King Packaged Materials Company, a division of KPM Industries Ltd., held the official opening of its new Boisbriand, QC, Canada, production facility. The following people were on hand for the official ribbon-cutting ceremony: Jim O'Neill, President; Joe Hutter, Vice President of Sales; Hugh Macpherson, Vice President of Operations; and Marlene Cordato, Mayor of Boisbriand.

The new facility will replace the company's first Quebec plant, which was purchased in 1971 in the town of St. Thérèse de Blainville. It is the most advanced plant of its kind in the world. O'Neill emphasized that this significant investment illustrates the company's long-term commitment to the province of Quebec.

The 150,000 ft^2 (13,935 m^2) facility, located at 3825 Alfred-Laliberté Street in Boisbriand, was purchased and modified in 2012. The facility specializes in the production of shotcrete, concrete, mortar, and grout to large building construction sites and underground mines in packages ranging from 66 to 3307 lb (30 to 1500 kg).

The new facility began operations in January 2013. A much-improved aggregate drying process, robotic packaging systems, and fully automated computerized batching systems have provided the company with improved energy efficiency, greater production capacity, and improved batching accuracy.

The company was founded in 1928 by William Whittaker King and operates today under the name KPM Industries Ltd. Its King Packaged Materials Company division manufactures a wide range of prepackaged cementitious products for construction, mining, masonry, and consumer markets across Eastern Canada and much of Northeastern United States.

Quikspray Introduces New Carrousel Pump Model 15010HP-3

Quikspray, Inc., has introduced a new Carrousel Pump Model 15010HP-3 designed for the commercial coatings industry. This Carrousel Pump is manufactured for high-production patching work or for small complete high-production applications, including stucco, cement textures, shotcrete, waterproofing, concrete repair products, or most heavy-bodied products.

The peristaltic action allows for low/no maintenance, and it is extremely easy to operate with unskilled labor. The time-proven, easy-flow Q & Q couplings are standard on this pumping system, so high material flow can be expected with less power needed. The unit is electrically powered with a 220 VAC motor and variable speed controls. This model of Carrousel Pump is also available with a hydraulic or pneumatic motor with the same production; a 110 VAC system is also available for those areas where 220 VAC power is not available. For more information, please contact Quikspray, Inc., at (419) 732-2611 or visit **www.quikspray.com**.

Shotcrete Calendar

OCTOBER 19, 2013
ASA Fall 2013 Committee Meetings
Hyatt Regency & Phoenix Convention Center
Phoenix, AZ
www.shotcrete.org
H-Remington A&B
Tentative Schedule
(No registration required for attendance)
8:00 am to 9:00 am | ASA Education Committee
9:00 am to 9:50 am | ASA Sustainability Committee
9:50 am to 10:10 am | Morning Networking Break
10:10 am to 11:00 am | ASA Pool & Recreational Committee
11:00 am to 12:00 pm | ASA Safety Committee
12:00 pm to 12:30 pm | Lunch
12:30 pm to 1:20 pm | ASA Publications Committee
1:20 pm to 2:40 pm | ASA Marketing & Membership Committee
2:40 pm to 3:00 pm | Afternoon Networking Break
3:00 pm to 4:00 pm | ASA Underground Committee
4:00 pm to 5:30 pm | ASA Board of Direction

OCTOBER 20-24, 2013
ACI Fall 2013 Convention
Theme: "Innovation in Conservation"
Hyatt Regency & Phoenix Convention Center
Phoenix, AZ
www.concrete.org
Schedule of shotcrete-related ACI Committee Meetings
(Convention registration required for attendance)
C660, Shotcrete Nozzleman Certification
Sunday, 10:00 am to 12:00 pm, H-Phoenix East
506, Shotcreting
Tuesday, 8:30 am to 11:30 am, H-Cowboy
506-A, Shotcreting-Evaluation
Monday, 1:30 pm to 3:00 pm, H-Boardroom
506-B, Shotcreting-Fiber-Reinforced
Sunday, 1:30 pm to 2:30 pm, H-Phoenix East
506-C, Shotcreting-Guide
Monday, 8:30 am to 10:30 am, H-Russell
506-E, Shotcreting-Specifications
Monday, 10:30 am to 12:30 pm, H-Russell
506-F, Shotcreting-Underground
Monday, 4:30 pm to 5:30 pm, C-103 B
506-G, Shotcreting-Qualifications for Projects
Monday, 3:00 pm to 4:30 pm, H-Boardroom

NOVEMBER 9-14, 2013
2013 International Pool | Spa | Patio Expo
Theme: "Building Beyond the Borders"
Register using ASA's source code: BN05 for FREE Expo only and 15% off Conference Packages
Mandalay Bay Convention Center
Las Vegas, NV
www.poolspapatio.com

NOVEMBER 12-13, 2013
ASA's Nozzleman Education Class
in conjunction with the 2013 Pool | Spa | Patio Expo
Tuesday, November 12: 3:00 pm to 6:00 pm;
Wednesday, November 13: 8:00 am to 12:00 pm
Mandalay Bay Convention Center
Las Vegas, NV
www.poolspapatio.com
This 7-hour program is a requirement for all pool builders wishing to pursue certification as an ACI Shotcrete Nozzleman through ASA. It also provides a great overview of the shotcrete process for owners, contractors, and project managers.

NOVEMBER 13-15, 2013
ICRI 2013 Fall Convention
Theme: "Looking Back—ICRI Celebrates Its 25th Anniversary"
Fairmont Chicago, Millennium Park
Chicago, IL
www.icri.org

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

JANUARY 20-24, 2014
2014 World of Concrete—Your Success Is Our Legacy
Exhibits: January 21-24
Seminars: January 20-24
Visit ASA's Booth #S10839 (New location!)
Register using ASA's source code:
A17 for FREE Exhibit
Only Registration (restrictions apply)
Las Vegas Convention Center
Las Vegas, NV
www.worldofconcrete.com

JANUARY 20, 2014
ASA WOC 2014 Committee Meetings
Las Vegas Convention Center
Las Vegas, NV
www.shotcrete.org

JANUARY 21, 2014
ASA Shotcrete Nozzleman Education Class
Speaker: Oscar Duckworth
in conjunction with WOC 2014
9:00 am to 4:00 pm
WOC Registration code: ASATU
Las Vegas Convention Center
Las Vegas, NV
www.worldofconcrete.com
This 7-hour program is a requirement for all nozzlemen wishing to pursue certification as an ACI Shotcrete Nozzleman through ASA. It also provides a great overview of the shotcrete process for owners, contractors, and project managers.

JANUARY 21, 2014
ASA Annual Outstanding Shotcrete Project Awards Banquet
Venue to be determined
Las Vegas, NV
www.shotcrete.org

JANUARY 22, 2014
ASA Shotcrete Seminar: Shotcrete for Infrastructure and Building Repair, Rehabilitation, and Repurposing
Speakers: Charles Hanskat and Marcus von der Hofen
in conjunction with WOC 2014
1:30 pm to 3:00 pm
WOC Registration code: WE139
Las Vegas Convention Center
Las Vegas, NV
www.worldofconcrete.com

FEBRUARY 23-26, 2014
2014 SME Annual Meeting & Exhibit
Theme: "Leadership in Uncertain Times"
Salt Palace Convention Center
Salt Lake City, UT
www.smenet.org/meetings

MARCH 22, 2014
ASA Spring 2014 Committee Meetings
Grand Sierra Resort
Reno, NV
www.shotcrete.org

MARCH 23-27, 2014
ACI Spring 2013 Convention
Grand Sierra Resort
Reno, NV
www.concrete.org

JUNE 22-25, 2014
ASTM International Committee C09, Concrete and Concrete Aggregates
Sheraton Toronto
Toronto, ON, Canada
www.astm.org

OCTOBER 25, 2014
ASA Fall 2014 Committee Meetings
Hilton Washington
Washington, DC
www.shotcrete.org

OCTOBER 26-30, 2014
ACI Fall 2014 Convention
Hilton Washington
Washington, DC
www.concrete.org

DECEMBER 7-10, 2014
ASTM International Committee C09, Concrete and Concrete Aggregates
Sheraton New Orleans
New Orleans, LA
www.astm.org

AMERICAN SHOTCRETE ASSOCIATION

38800 Country Club Dr., Farmington Hills, MI 48331
Phone: (248) 848-3780 Fax: (248) 848-3740
E-mail: info@shotcrete.org Web site: www.shotcrete.org

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

AMERICAN SHOTCRETE ASSOCIATION

ASA Membership Benefits

	Corporate	Corporate - *Additional Individual*	Individual	Nozzleman	Employees of Public Authorities / Agencies	Student
Annual Dues	$750	$100	$250	$50	Free	Free
Company and specialty information listed in ASA's online Buyers Guide and in hard copy via *Shotcrete's* annual Buyers Guide	X					
Discount on ACI Shotcrete 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	
Discounted ASA Member prices on all ASA products	X	X	X	X	X	X
Networking and participation opportunities at Annual Membership Meeting and committee meetings	X	X	X	X	X	X
Opportunity to respond to bids from our Online Project Bid Submittal Tool	X	X				
Subscription to quarterly *Shotcrete* magazine (hard and electronic copy)	X	X	X	X	X	X*
Links to shotcrete related government projects open for bid (*sent twice a month in the member edition of the ASA e-newsletter*)	X	X	X	X	X	X
Permission to include ASA logo on corporate letterhead and business cards	X	X	X		X	
Permission to display ASA logo on company website	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 Onsite Learning 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

New ASA Members

CORPORATE MEMBERS

American Shotcrete Construction
www.americanshotcreteconstrucionaz.com
Mesa, AZ
Primary contact: Robert Porter
bfish519@aol.com

Buesing Corp.
www.buesingcorp.com
Phoenix, AZ
Primary contact: Kevin Somerville
ksomerville@buesingcorp.com

BVR Construction Company Inc.
Churchville, NY
Primary contact: Chip Stephenson
cstephenson@bvrconstruction.com

MacLean Engineering & Marketing Co. Ltd.
www.macleanengineering.com
Collingwood, ON, Canada
Primary contact: Steve Czerny
sczerny@macleanengineering.com

Northwest Cascade Inc.
www.nwcascade.com
Puyallup, WA
Primary contact: Douglas Watt
dougwatt@nwcascade.com

Quikspray, Inc.
www.quikspray.com
Port Clinton, OH
Primary contact: T. Park McRitchie
park@quikspray.com

Shotcrete Concrete Contractors Association
www.shotcrete.us
Los Gatos, CA
Primary contact: Chris Zynda
czynda@jjalbanese.com

Wildcat Concrete Services Inc.
http://wildcatcompanies.com/concrete.html
Topeka, KS
Primary contact: Stuart R. Johnson
stuartj@wildcatconcrete.com

CORPORATE ADDITIONAL INDIVIDUALS

Jeff B. Carr
Active Minerals International
Hunt Valley, MD

INDIVIDUALS

Bernard Brady
Brady Construction Inc.
San Francisco, CA

PUBLIC AUTHORITIES & AGENCIES

Mel Long
SNWA
North Las Vegas, NV

Robert L. Winiecke
City of Great Bend
Great Bend, KS

STUDENTS

Isabelle Fily-Pare
Université Laval
Quebec, QC, Canada

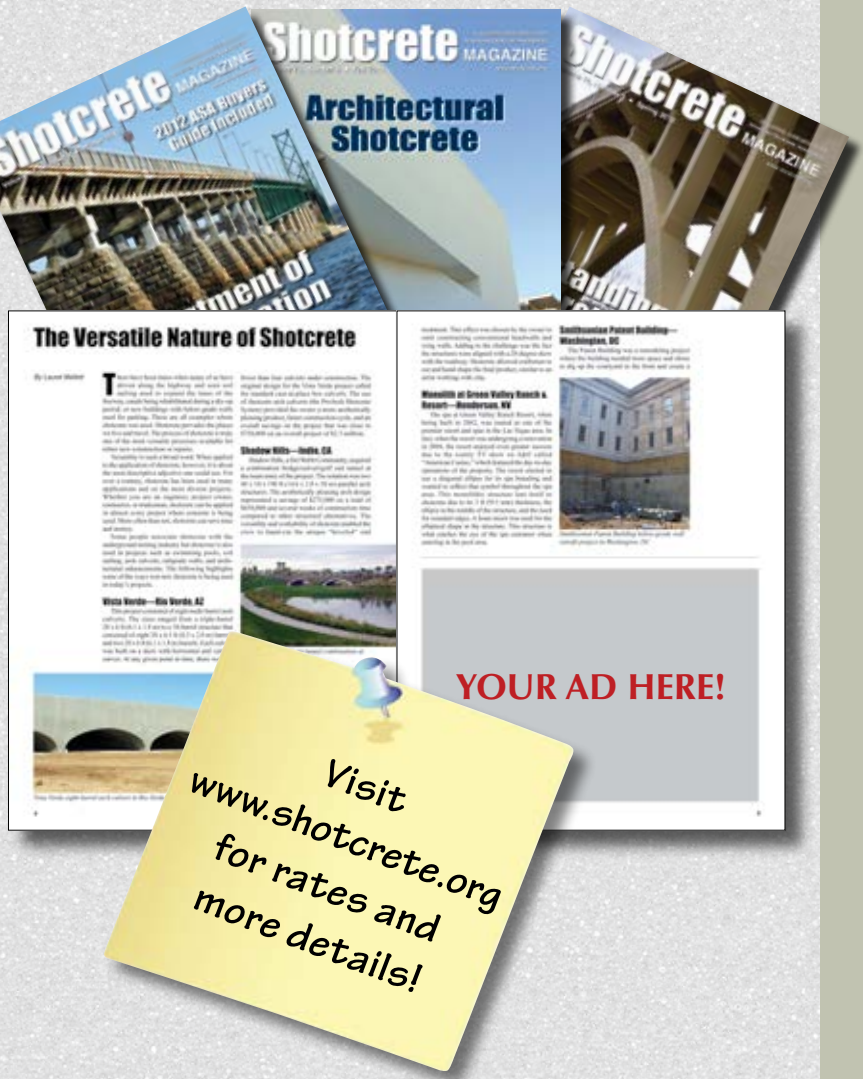
Shotcrete

2013 MEDIA KIT

A quarterly publication of the American Shotcrete Association

MAGAZINE

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



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

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

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