Shotcrete MAGAZINE

A quarterly publication of the American Shotcrete Association

Volume 12, Number 1 ◆ Winter 2010

Form and Pump or Shoot?

2010 ASA Buyers Guide Included

Some like it WET...

Some like it DRY...

We've Got The Best of Both Worlds.

REED **WET-mix Shotcrete Pumps and**
DRY-mix "*Guncrete*" Gunite Machines.
On the job since 1957 and still
the best in the industry.

Call us Toll-Free at 888-779-7333

REED

REED - An Independent Member of the Shea Family of Companies
13822 Oaks Avenue, Chino, California 91710 • 909-287-2100 • Fax: 909-287-2140 • Toll-free: 888-779-7333 • www.reedpumps.com

Circle #22 on reader response form—page 68

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

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**

Shotcrete MAGAZINE

Volume 12, Number 1
Winter 2010

Features

Departments

On the cover: Bellarmine College in Santa Clara, CA. Photo courtesy of Chris Zynda, Joseph J. Albanese Inc.

Shotcrete—A Proven Process for the New Millennium

Thank You to a True Leader

By Chris Darnell, ASA Executive Director

As ASA President Chris Zynda's term draws to an end, now is the time to take a few minutes and reflect on Chris's presidency and leadership.

The list of accomplishments and improvements at ASA during his presidency is significant and would require more space than is available in this commentary. Instead, I would like to take this opportunity to comment on one aspect of Chris's presidency and long history with ASA—his leadership by example.

All too often, the image many have of an individual who is active in an association is that of a tie-wearing, very proper, office pencil pusher. Unfortunately, this stereotyping can be extremely damaging when it scares off potential members considering that important step of getting more involved in the management of their association.

From "race trucks" to "hard hats and beer cans," if you have read *Shotcrete* magazine's President Messages and the Safety Shooter articles that Chris has authored over the last 2 years, you have caught a glimpse of Chris's colorful, to-the-point, knowledgeable, and just plain get-it-done nature. Chris Zynda does not fit the above-mentioned association stereotype—he shatters it!

In shattering those preconceptions, Chris has exhibited some of his finest leadership qualities. Leadership includes the task of showing the way; and Chris has definitely shown the way, or perhaps "kicked the door open," in his unique style for everyone in the shotcrete industry to participate in their association.

One of the great strengths of ASA is the diverse make-up of its leadership and committee members. Not only is there diversity regarding the areas of the shotcrete industry represented but also in the very colorful personalities and individual styles, which makes ASA meetings very effective and entertaining. That's correct—I said the committee meetings are entertaining. If you have not attended an ASA meeting in the past, you are missing out. These are not monotone, business-as-usual, boring meetings. These meetings are populated by knowledgeable and passionate members who know how to get the job done and have fun doing it.

One of Chris's passions and a theme of a past President's Message (his race truck)

The point is that for ASA to truly advance and grow the shotcrete industry, the people who make up the industry must participate. You have knowledge, experience, and ideas that are critical to ASA's success. If you have hesitated to participate because you did not think you were the association "type," please reconsider. Chris Zynda has shown us all how critical participation is from real industry people from all aspects of the industry and with all personalities and interests.

So how about it? If you are planning to attend the next World of Concrete, please consider attending the ASA committee meetings on February 1 and/or the Annual Meeting and Awards Banquet on February 2. It's always an interesting, lively, and entertaining time that you will benefit greatly from.

On a personal note, thanks, Chris, for your patience and help bringing along a rookie Executive Director this year. I look forward to continuing to work with you in the years ahead. And on behalf of the membership of ASA and the entire shotcrete industry, thank you for your leadership; commitment; hard work; and, perhaps most significantly of all, acting as an outstanding example for everyone on the fence about becoming involved.

ASA President Chris Zynda

2008 and 2009 Award Winners:
ASA Outstanding Infrastructure Project of the Year

The Dan Ryan Expressway, one of the country's largest and busiest expressways, runs through the heart of the city of Chicago and was part of the biggest reconstruction plan in Chicago history. This 11-1/2 mile bridge is elevated 60 feet above numerous local roads, businesses, and railways in Chicago. Shotcrete was used to successfully complete this project with zero accidents!!

American Concrete Restorations, Inc., received an Outstanding Subcontractor Merit Award from the Illinois Roadbuilder's Association for this project, and the Dan Ryan Expressway was named the 2009 ASA Outstanding Infrastructure Project of the Year. Once again, thank you to all who participated in this job and helped make American Concrete Restorations, Inc., a two-time winner of this award.

Abraham Lincoln Memorial Bridge, the longest bridge in Illinois, is supported by 86 piers and elevated approximately 70 feet above the Illinois River, numerous local roads, lakes, wetlands, and railroads.

The bridge was named the 2008 ASA Outstanding Infrastructure Project of the Year and voted #7 on the 2008 list of Top 10 Bridges in *Roads & Bridges* magazine.Thank you to all those who participated in completing this job safely and successfully!

American Concrete Restorations, Inc.

- Shotcrete
- Hydrodemolition
- Mobile Mixed Concrete
- Engineering Consultation

Amerconcrete@aol.com
www.americanconcreterestorations.com

Over 30 Years of Experience *Nationwide Service*

Phone: 630-887-0670 **Fax: 630-887-0440**

Circle #45 on reader response form—page 68

Reprinted with permission from the April 2009 edition of Concrete Monthly *(www.concretemonthly.com)*

Up Against a Wall

Project time crunch turns contractor to shotcreting walls for greater efficiency

During construction of the Atlantic Times Square mixed-use development project in Monterey Park, CA, the concrete contractor is taking the route of shotcreting the walls to realize added efficiency. With the "green-friendly" shotcrete process, forms are set on only one side of the wall; the nozzleman shoots shotcrete into the open side; and the crew hand-finishes the exposed side. The forms are then pulled and reused to set the next wall on this particular job

The tight construction deadline of the Atlantic Times Square project, a large-scale, mixed-use development in Monterey Park, CA, put the concrete contractor literally up against a wall to build the project's walls faster and place the concrete slabs at high speed. To solve both challenges, the contractor CS Concrete Solutions Inc., of Mission Viejo, CA, turned to uncommon construction techniques and high-performance equipment to step up the pace.

"We're shotcreting the walls with greater speed than possible with block construction or poured-in-place," says Marty Vasquez, General Superintendent of Concrete Solutions, "and we're relying on a Thom-Katt trailer-mounted pump to handle all the shotcrete work under an aggressive schedule. Plus, we're using Putzmeister boom pumps for their extremely high outputs in placing the concrete faster for the slab work."

The need for speed is critical on the Atlantic Times Square project. It is considered one of the largest projects under construction in the Los Angeles area today and one that requires highly efficient construction methods to achieve its targeted winter 2009 opening.

To help meet the fast-track completion date, Concrete Solutions is depending on the state-of-the-art equipment and prompt services of three key subcontractors: Global Shotcrete, Inc., of Ventura, CA, to supply the high-performance trailer-mounted pumps; Fleming Concrete Pumping Inc. of Santa Ana, CA, to provide the high-volume truck-mounted concrete boom pumps; and Cemex, to deliver the specified concrete mixture from its two local plants in Los Angeles and Azusa, CA. The $200 million project is under the direction of general contractor Pan Construction Inc. of Rosemead, CA.

Unbelievable Size

The Atlantic Times Square project is under construction in the heart of Monterey Park. Residents and visitors will soon enjoy the convenience of the first mixed-use development in the San Gabriel Valley.

Developer Kam Sang Company Inc. of Arcadia, CA, has specifically designed the huge complex to satisfy the need for retail and residential space in one place. Inspired by Times Square in New York City, the center stretches a full city block adjacent to the I-10 San Bernardino Freeway.

Offering more than 230,000 ft^2 (21,368 m^2) of retail and entertainment space, the complex will be anchored by a 14-screen AMC Theater Cineplex and 24-Hour Fitness, as well as a mixture of national and local businesses. The enclosed community also integrates 210 luxury condominiums and parking for 1640 vehicles.

The magnitude of the job site is difficult to comprehend. With three levels below grade and six levels above, it is about the size of six football

The Thom-Katt TK 50HP trailer pump is on the job site twice a week, shooting 80 to 130 yd³ (61 to 99 m³) of shotcrete during an average 8- to 10-hour day

Numerous walls are being placed with shotcrete, including the exterior walls around the perimeter of the large 330,000 ft² (30,658 m²) complex, plus all major interior walls

fields. Therefore, the sheer volume of concrete to be pumped, in addition to the incredible number of walls to shotcrete, underscores the importance of reliable, high-performance pumping equipment to meet an important completion date.

Shotcreting Speed

Traditionally, concrete walls are either constructed of concrete masonry units (CMUs) or poured-in-place. For this project, however, the contractor is taking a rather unusual approach and is instead using shotcrete to construct the interior and exterior walls. The technique is significantly improving efficiency to meet the demanding deadline.

"If there's a wall to be done on this major job, we're shooting it with shotcrete," owner Joe Able of Global said. "The speed of shotcreting allows contractors to push jobs forward faster than other alternatives. Plus, the setup process is 'green-friendly' because only half the wooden forms are needed and can be reused several times over."

For this particular job, poured-in-place walls would have been the typical choice, consisting of a reinforcing bar core and using two braced wooden forms and then pouring concrete in place from the top.

With the shotcrete process, however, wooden forms are set on only one side of the wall instead of two and formed all the way to the top instead of in stages; the same amount of reinforcing bar is used. This process is reducing labor costs and cutting the amount of material required roughly in half. Additionally, precious space on the job site is saved because the crew works from only one side of the wall—an important benefit on the extremely congested construction site.

Once the forms are set, the nozzleman shoots shotcrete into the open side of the forms and the crew hand-finishes the exposed side. Then the forms are pulled and reused to set the next wall.

"It's just so much faster to shotcrete the walls, and there's plenty of them to shoot on this major project," Vasquez said. "There's the structural exterior walls around the perimeter of the 330,000 ft² (30,658 m²) complex, plus all the interior walls, which include three levels of underground parking, a retail level, and five residential floors. Global is doing a great job while paying attention to all the details."

Shooting 80 to 130 yd³ (61 to 99 m³) of shotcrete during an average 8- to 10-hour day, Global is on the job site about twice a week with their Thom-Katt TK 50HP. Putzmeister has renamed the model "Katt-Kreter" to call attention to the unit's special shotcreting features. The pump has plenty of power. It is capable of outputs up to 54 yd³ (41 m³) an hour and maximum pressures to 1450 psi (9997 KPa). Therefore, it can pump the 5000 psi (34.5 MPa) mixture. Because of the unit's shotcreting capabilities, Global has two of the same model in its fleet. "We're relying on our Thom-Katts because the pumps just don't break down," Able said, "and that's a 'must' because we're doing such a substantial amount of shooting on this particular job."

Fleming Concrete Pumping of Santa Ana, CA, is expected to pump over 65,000 total yd³ (49,696 m³) of concrete for the footings, columns, and slabs upon the project's completion

With its high-performance trailer pump and shotcreting expertise, Global Shotcrete of Ventura, CA, plans to shoot approximately 4000 total yd³ (3058 m³) of shotcrete for the walls on the large-scale project

Gaining Popularity

Although shotcrete is not the norm for placing commercial walls in southern California, Global has handled various jobs in this manner before. The prominent Atlantic Times Square project, however, is their largest single project to date using this distinctive approach and, consequently, it should ultimately help the shotcrete method gain wider acceptance.

Able started his shotcrete business 3 years ago, initially renting equipment and then buying two Putzmeister trailer pumps. Able states, "Although shotcrete is only a small percentage of our industry today, our company has been experiencing explosive growth." Able further stated, "The popularity of shotcreting is definitely catching on with contractors, as they are finding it an attractive alternative in saving time and money."

Able does note that "although the growth of shotcreting offers our business a great opportunity, it is extremely hard work and each day brings unexpected challenges to tackle."

Keeping Up the Pace

While the walls are getting the shotcrete treatment, the footings, columns, and slabs are being pumped with concrete. Fleming Concrete Pumping has been on the job with almost every boom pump size in the company's extensive fleet, ranging up to 63Z-meters.

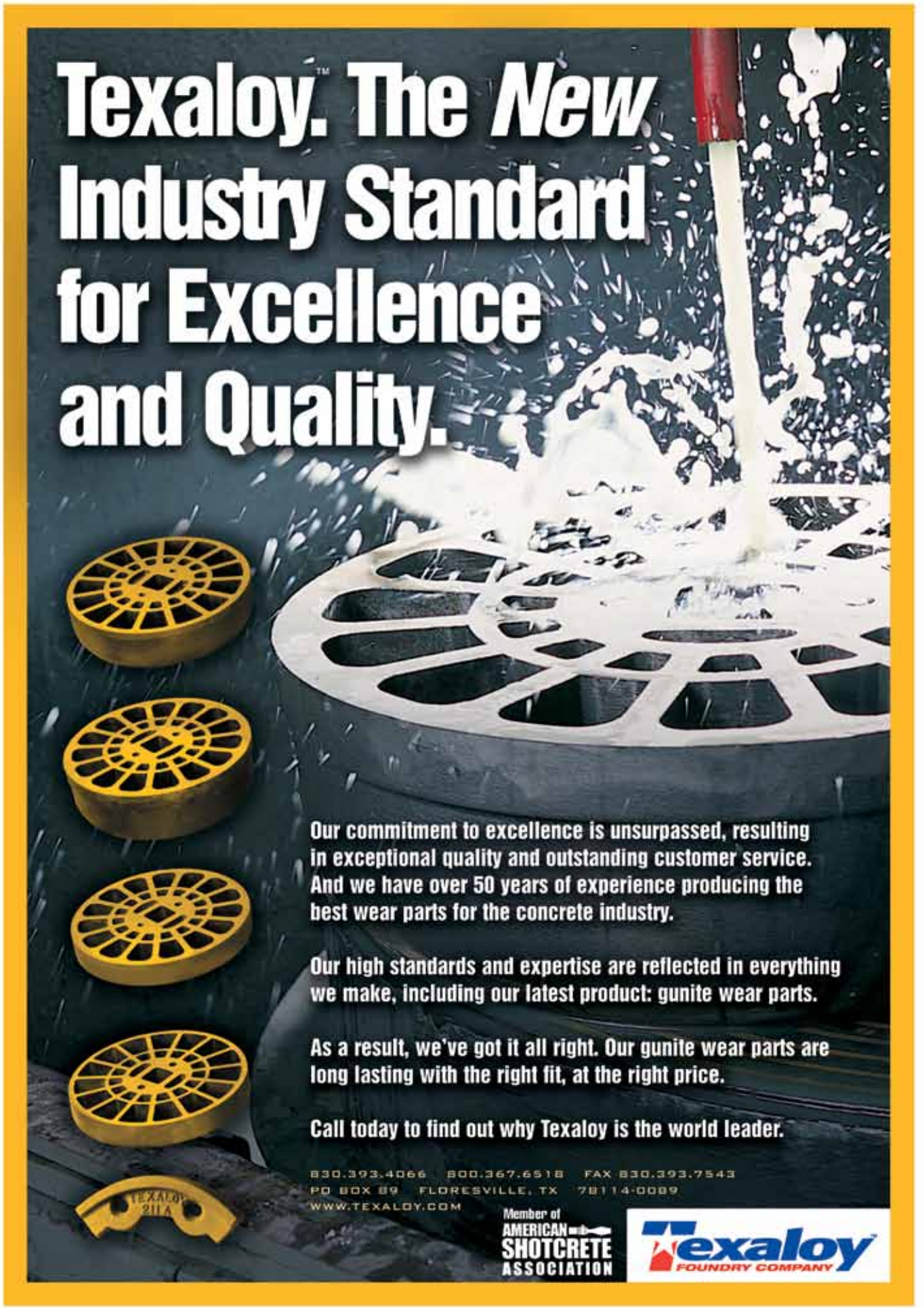
Due to the especially crowded job site conditions, setup of the boom pumps often takes place in the street or in specific areas on the job site that are far from the point of concrete placement. Therefore, the longer reach of the 63Z-meter is favored for extending its boom 203.75 ft (62 m) vertically and 190.58 ft (58 m) horizontally to access the pours. Plus, all the boom pump models, whether with a .16H and .20H pump cell, can deliver the high concrete volumes the contractor demands.

"For the decks, we're pumping around 190 yd³ (145 m³) an hour with the .16H pump cell on our 63Z-meter," Alan Fleming, co-owner of Fleming, said. This is providing the contractor with the high outputs required, as it just shy of the pump cell's maximum 210 yd³ (160 m³) an hour output.

Vasquez said the minimum pour is 22,000 ft² (2044 m²), using about 900 yd³ (688 m³) of concrete, so high volume pumps are needed to place the concrete quickly. "It ultimately saves us a tremendous amount of man hours," he said.

Totally Fast, Totally Efficient

To meet a fast-paced project completion, more than 65,000 total yd³ (49,696 m³) of concrete will be pumped and about 4000 total yd³ (3058 m³) of shotcrete placed while using the advanced technology of today's pumping equipment to handle the job at high speed.



Circle #35 on reader response form—page 68

Westview Tower Underside Roof Slab Concrete Repairs

By R. Curtis White Jr.

The Westview Tower Apartment complex is a 34-year-old, 13-story cast-in-place concrete structure in Knoxville, TN. Within a stone's throw of the University of Tennessee, it is a home for the elderly set amid the foothills of the Great Smoky Mountains. The facility had recently changed hands and was in the process of a complete facelift and modernization when the new owner's representative discovered severe structural problems that had been hidden by acoustic tiles placed on the ceiling of the 13th floor living units. Severe delamination of the underside of the flat-plate roof slab was revealed when these tiles were removed. The owners consulted with their structural engineer, who brought in a concrete restoration specialist. The concrete repair specialist, in turn, called a shotcrete consultant.

Material testing started almost immediately on the conventionally-reinforced cast-in-place two-way flat-slab roof. The charge to the engineers was to determine the cause of corrosion of the slab reinforcing steel and develop recommendations for repair. Test results indicated that the underside of the concrete was carbonated up to 2 in. (50.8 mm) deep, which had caused the lower layer of reinforcing steel to corrode and spall the concrete. Further inspection determined that this condition was isolated to the underside of the 13th floor roof slab but extended throughout the entire 10,000 ft^2 (929 m^2) of the building footprint.

Fig. 1: Westview Towers building

Fig. 2: Severe spalling of underside of roof slab

Once determination was made that concrete would have to be removed and replaced to a depth of 1.5 to 2 in. (38 to 51 mm) throughout the entire underside of the slab, attention turned to means and methods. All methods would require the relocation of the residents on the 13th floor and possibly two floors below that. In addition, complete removal of all partition walls would be necessary to provide access to the ceiling. Utilities and chases, however, had to be maintained so that the remainder of the building could continue to be occupied. Parts of the 12th floor would have to be evacuated to accommodate the shoring required to support the compromised roof slab during renovation. Additionally, under a form-and-pour scheme, parts of the 11th floor would also have to be cleared.

Three methods of concrete rehabilitation were proposed and included as acceptable alternates for bid solicitation. These were form-and-pump, form-and-pour, and shotcrete. Based on review of the bids and interviews with the specialty contractors, the shotcrete process was selected by the design team and the owner as being the most confident and time-sensitive approach to limit disruption to the elderly residents and provide for a reliable and verifiable, permanent repair.

A primary concern to the owner was the additional loss of revenue and added expense of relocating the lower floor residents. Any combination

Fig. 3: Polished section of a concrete core illustrating corrosion in carbonated zone

of forming would have required two floors of shoring due to the larger demolition areas required to make forming feasible. The necessity of forming around all the utilities and chases further complicated the forming option. In addition, a form-and-pour approach would have required many breaches of the roof membrane for access holes to place the concrete. In contrast, using shotcrete allowed for the demolition and placement operation to proceed in 5 ft (1.5 m) wide strips or one-quarter of a bay width in the short dimension of the building plan. Rapid strength gain allowed the contractor to leap-frog the strips to keep the operation continuous; and because shotcrete requires no forms, the utility penetrations were handled with ease. Now that the demolition and applied load had been significantly reduced, only one floor was required for shoring and only one-half of that floor at a time. Because the bond between the shotcrete strips was equal to that between the sound roof slab and the shotcrete, cold joints and suspect epoxy bonded joints behind formwork were eliminated.

Demolition was performed using hand-held pneumatic chipping hammers. Hydrodemolition was also used where possible. This presented its own challenges with capturing water above 11 floors of occupied space (remember all the utility penetrations?). In the end, it was more cost effective to continue the hand demolition. The extent of removal was verified by using a phenolphthalein solution on the chipped surface. Phenolphtalein is a pH indicator that turns bright purple on noncarbonated concrete. A purple color indicates the carbonated concrete had been effectively removed. After removal and confirmation with phenolphthalein, the reinforcing steel and concrete surface was blasted with abrasive, cleaned, rinsed with clean water, and left in a surface saturated dry (SSD) condition.

As a part of the bid process, the shotcrete contractor proposed using a polypropylene-fiber-reinforced, silica-fume enhanced, dry-mix shotcrete for the replacement material and process. The shotcrete material was site-batched using local aggregate and Type I/II portland cement. Five percent by weight of cement was replaced by micro-silica, which was introduced at the same time as the cement and sand. The batching process took place at ground level and the material was delivered to the 13th floor using a 1300 ft^3/m (36.8 m^3/m) air compressor and 1.5 in. (38 mm) material hose. Domestic water pressure on the working floor was sufficient for the water ring.

Initially, ground wires were strung to control grade, elevation, and flatness (a prime concern because the finished shotcrete would be the exposed ceiling). The ACI-certified nozzlemen had to place the material overhead to tight tolerances so that minimal finishing was required and bond was not compromised while working the plastic material. After the first few strips were completed and finished, a 10 ft (3 m) straight edge was used to mark the grades and the shotcrete was hand-trimmed to those marks. Finally, a light flash coat was applied to hide any trowel marks and the entire ceiling was given a textured paint coat for the final exposed ceiling.

To ensure that a quality product was delivered by the contractor, bond testing was performed in accordance with ASTM C1583-04, "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-Off Method)." Bond strengths ranged from 90 to 250 psi (0.9 to 1.7 MPa) with failure typically occurring in the parent concrete. Compressive strengths generallyranged from 3500 psi (24 MPa) in 3 days to

Fig. 4: Concrete core illustrating corrosion within carbonated zone

Fig. 5: Underside of roof slab illustrating difference between chipped area and hydrodemolition

Fig. 6: Carbonated concrete removed and carbonation checked with phenolphthalein

Fig. 7: Removal of existing concrete alongside completed shotcrete repair

Fig. 8: Bond test core with failure within the substrate concrete

Fig. 9: Completed repair

10,000 psi (69 MPa) in 28 days. Bond tests, cores from shotcrete panels, manual sounding of chipped and completed surfaces, and phenolphthalein solution checks were all good inspection and quality assurance techniques. The confidence of the owner, the knowledge of the engineers, the selection of shotcrete, the experience of the contractor, the ACI certification of the nozzlemen, and the experience and skill of the finishers were all keys to the success of this project.

The concrete repair portion of this project was completed in approximately 90 days including shoring installation while maintaining occupancy for the elderly residents in the lower 11 floors. Most of the occupants got to know the workers on a first-name basis, inquired about the progress regularly, and were relieved when the work was completed and they could return to their accustomed peace and quiet in the Tennessee hills.

Westside Tower Repairs

Owner's Representative
Barry Brooke
Lawler-Wood, LLC
Knoxville, TN

Structural Engineer
David Berry
Professional Engineers, Inc.
Knoxville, TN

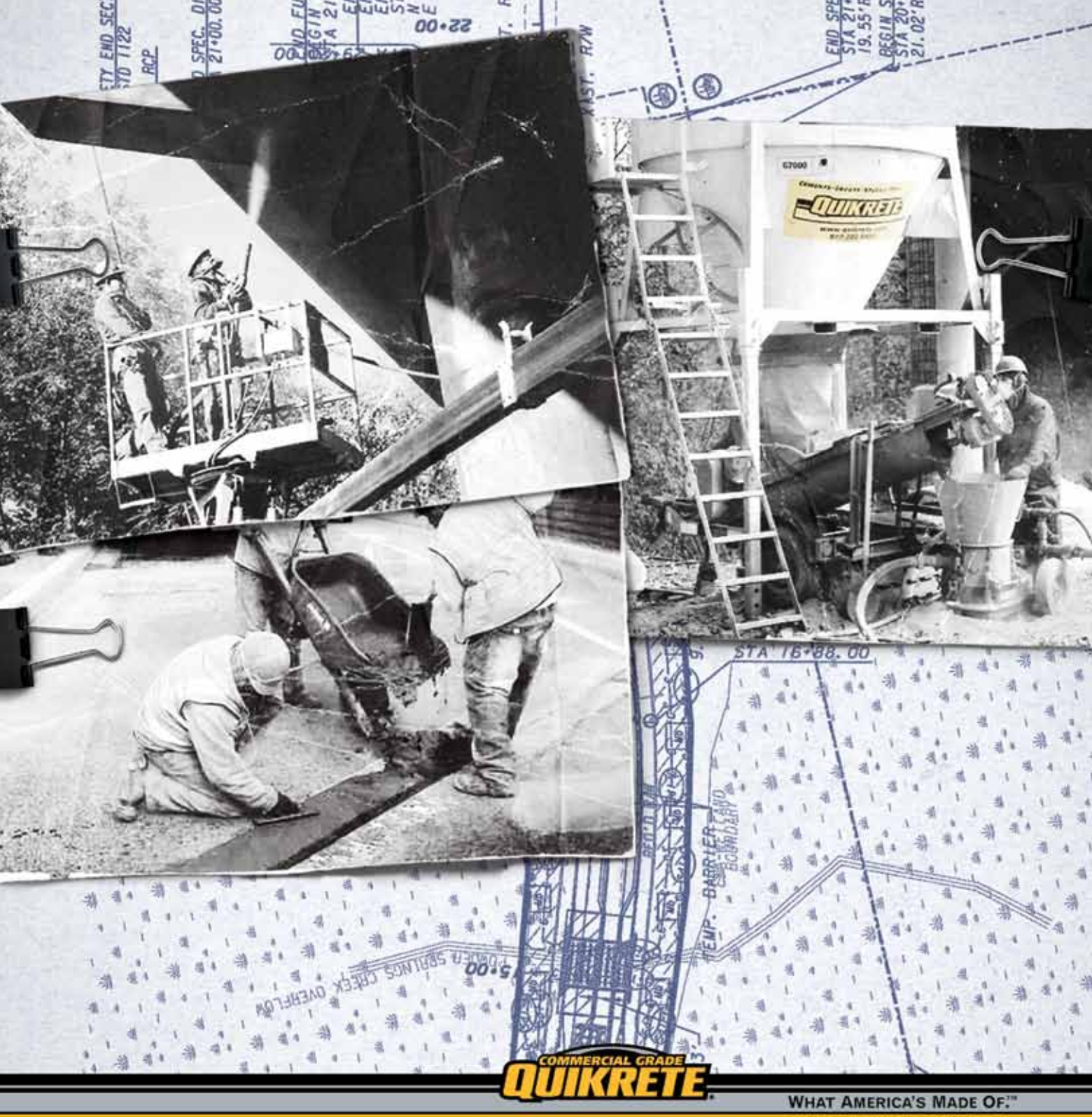
Concrete Restoration Specialist
Kurt Heinrichs
TEC Services, Inc.
Lawrenceville, GA

Shotcrete Consulting
Peter Tatnall
Performance Concrete Technologies
Atlanta, GA

Shotcrete Contractor
Coastal Gunite Construction Company
Cambridge, MD

Materials Supplier
Rinker Materials
Knoxville, TN

R. Curtis White Jr. *is President of Coastal Gunite Construction Company, a 25-year-old firm specializing in the repair and restoration of concrete structures using the shotcrete process. Coastal Gunite is active east of the Mississippi River completing shotcrete projects for new basement wall construction, sewer rehabilitation, bridge restoration, building rehabilitation, and seawall reconstruction. Coastal Gunite has won awards from the American Shotcrete Association (ASA) and the International Concrete Repair Institute (ICRI) for bridge repairs in the Florida Keys, tunnel restoration in West Virginia, and cooling tower rehabilitation in northern Florida. White is a long-time member of ACI Committees 506, Shotcreting, and C660, Shotcrete Nozzleman Certification, and ASTM Committee C09.46, Shotcrete. He is one of the authors of the AASHTO-AGC-ARTBA Task Force 37, "Guide Specification for Shotcrete Repair of Highway Bridges." White is a founding member of ASA and ICRI.*



COMMERCIAL GRADE QUIKRETE®

WHAT AMERICA'S MADE OF.™

CEMENT & CONCRETE PRODUCTS™

Adheres to arches, overheads, decks and DOT specifications.

When bridge columns and pier hammerheads on Pennsylvania's Noblestown Road Bridge needed structural repair, QUIKRETE® Shotcrete MS with corrosion inhibitor got the job done. Crews were able to make full-depth, monolithic vertical and overhead repairs with virtually zero rebound. Plus QUIKRETE Shotcrete MS reaches 9,000 psi. With over 90 manufacturing plants, we can speed this and hundreds of other high-performance products to you nationwide. For a free construction product guide, visit quikrete.com or call 1-800-282-5828.

Circle #5 on reader response form—page 68

Shotcrete Boiled Water Absorption

By Louis-Samuel Bolduc and Marc Jolin

One of the benefits of choosing the shotcrete process over pump-and-pour systems is the rapidity of execution. Indeed, this unique placement technique ensures a quick application because very little formwork is required. The major difference, however, is that (in the case of shotcrete) the nozzleman plays an important role in the quality of the in-place concrete. For example, the nozzleman is responsible for the air velocity, the nozzling technique, the amount of water added (in dry-mix shotcrete), and the amount of set accelerator added at the nozzle (in accelerated wet-mix shotcrete). In addition to the usual compressive strength measurements of shotcrete, it is not uncommon in the industry to perform boiled water absorption (BWA) tests, as described in ASTM C642, to evaluate the overall quality of the shotcrete placement.

The subject of BWA measurement in shotcrete is the source of animated discussions both around the construction site and in technical committee meetings. The issue at hand is that contract documents often require the contractors to comply to a minimum value of compressive strength (ASTM C1604) and a maximum value of BWA (ASTM C642). Contrary to what is often conveyed in the industry, however, there is no direct relationship between the compressive strength of concrete and its BWA (refer to Fig. 1). Indeed, some parameters affect the BWA but do not necessarily affect the mechanical properties.

One can observe that the correlation is quite poor in Fig. 1, especially when the range between 4000 and 6500 psi (28 to 45 MPa) is considered (typical values for shotcrete). This is because the parameters that influence the shotcrete BWA are not fully correlated with the compressive strength. The potential problem on the job site is that to comply with the specified BWA, contractors and engineers end up in an iterative and expensive process trying to fix the mixture design. Which parameters to modify, however, are not well understood.

The debate intensifies when it comes to the choice of the maximum acceptable value itself. What is an acceptable BWA value? What is the limit beyond which the in-place shotcrete is too porous? Which parameters must be modified to reduce BWA values?

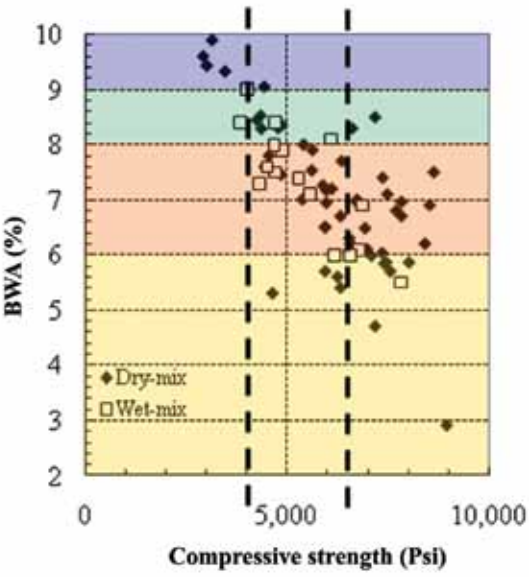


Fig. 1: BWA versus compressive strength (values compiled from projects at Laval University, Quebec City, QC, Canada)

It is the objective of this paper to provide some information that will hopefully help answer those questions. The first part of the article presents the mechanisms through which fluid can migrate through the concrete pore spaces. The second part presents some results from a study that was undertaken by the shotcrete team at Laval University.

Transport Mechanisms

Shotcrete is a porous material that comprises a solid matrix and a network of interconnected pores. The shotcrete porosity covers a wide range of pore size diameters (Neville 2000):

- The gel pores are smaller with a nominal diameter of approximately 8×10^{-5} to 12×10^{-5} mil (2 to 3 μm);
- The capillary pores have a median size of 0.05 mil (1.3 μm);

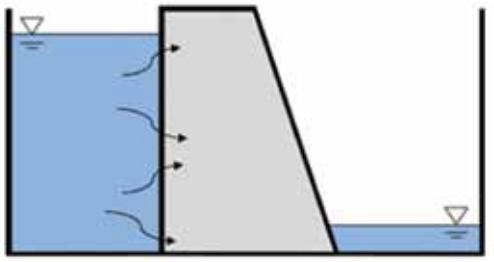


Fig. 2: Permeability

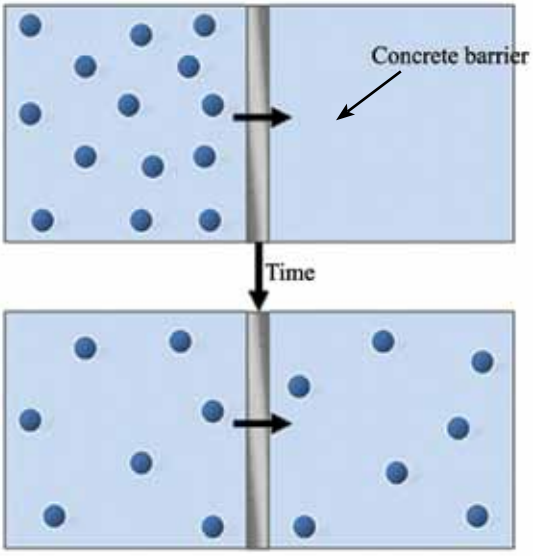


Fig. 3: Ionic diffusion

- The entrained air bubbles have a diameter of approximately 2 mil (50 μm); and
- The entrapped air and the compaction voids can reach the magnitude of over 1 in. (25.4 mm).

To illustrate the difference between the pore size diameters, comparing the gel pores to the compaction voids would be like comparing the size of a human to the size of Mars!

The porosity is therefore very complex, and the mechanisms controlling the movement of fluid (or contaminants) in the porosity received a lot of interest from researchers in the last decades. Why? Because most durability issues are related to these mechanisms (called transport mechanisms or transport properties). For example, reinforcement corrosion is initiated by the ingress of chloride, or by carbonation (which begins with the ingress of carbon dioxide in the concrete porosity). To make durable concrete, it is crucial to understand the material transport properties. The transport mechanisms can be roughly divided into three categories.

Permeability: movement of fluid (liquid or gas) resulting from a pressure (illustrated in Fig. 2).

The term permeability is widely used when it comes to the ingress of fluids in concrete. However, strictly speaking, a pressure must be involved to have the right to use the word permeability. Numerous test methods are available to measure the permeability of concrete, but none of them is standardized by an official standard organization.

Ionic diffusion: movement of ionic species resulting from a concentration gradient (illustrated in Fig. 3). Thermodynamic principles dictate that equilibrium must be established when a system is unstable. For instance, when concrete is immersed in water with a high concentration of salt, the chloride concentration in the concrete pore solution is lower than that of the salted solution. Consequently, the ionic species present in the salted water will migrate into the concrete pores, through the pore solution, until equilibrium is reached. The experimental evaluation of diffusion coefficient is laborious and time consuming. However, the research community came up with the rapid chloride penetration test (RCPT)

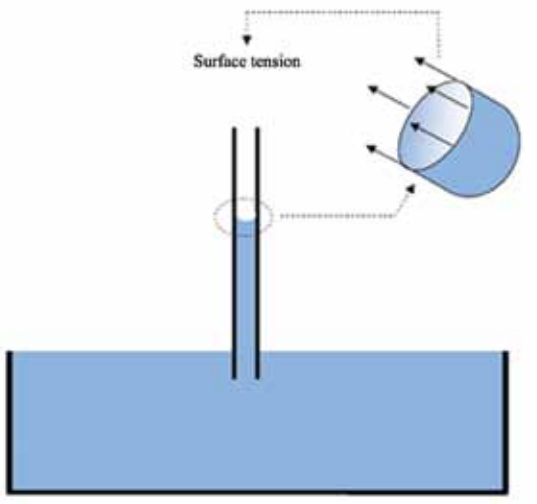


Fig. 4: Capillary absorption

(ASTM C1202) that can give a quick evaluation of the concrete diffusivity.

Capillary absorption: suction of water resulting from the surface tension exerted in the capillary porosity (illustrated in Fig. 4). When a capillary tube is immersed in water, the level rises. In concrete, capillary pores behave like a series of tubes. When a concrete sample is immersed, the capillary void system slowly fills with water. In North America, the principal test procedure to evaluate the capillary absorption is ASTM C642 (also known as the BWA test). This test also provides the volume of permeable voids (VPV). The difference between these two parameters is that BWA represents the mass ratio of water absorbed in the sample, whereas the VPV

Table 1: Mixtures Composition

Study	Mixtures	*w*/*cm*	Cement Type GU, lb/yd³ (kg/m³)	Sand (0 to 5 mm), lb/yd³ (kg/m³)	Crushed stone (2.5 to 10 mm), lb/yd³ (kg/m³)	High-range water-reducing admixture, mL/m³	Air-entraining admixture, mL/m³
Air content	65/35-500-3	0.40	843 (500)	1796 (1066)	967 (574)	0	0
	65/35-500-13	0.40	843 (500)	1796 (1066)	967 (574)	0	750
Aggregate gradation	50/50-450-5	0.45	758 (450)	1363 (809)	1363 (809)	1800	0
	65/35-450-5	0.45	758 (450)	1773 (1052)	954 (566)	2700	0
	80/20-450-5	0.45	758 (450)	2180 (1294)	544 (323)	3600	0
Paste volume	65/35-390-5	0.45	657 (390)	1909 (1133)	1028 (610)	4600	0
	65/35-450-5	0.45	758 (450)	1773 (1052)	954 (566)	2700	0
	65/35-530-5	0.45	893 (530)	1592 (945)	858 (509)	1060	0

Note : 1 mm = 0.04 in.

represents the volumetric ratio of water absorbed in the sample. Therefore, the two results measure the same porosity, but are expressed differently.

The purpose of this section is only to give a quick overview of the main transport mechanisms used to describe concrete. The interesting observation here is there is no single test or concept available to evaluate every transport property. For example, it is important to calculate the permeability of the concrete in a dam because an important pressure gradient is involved. Conversely, a concrete pier in salt water will need to resist corrosion by both limiting ionic diffusion and capillary suction.

The complete understanding of these mechanisms is beyond the scope of this study. The reader can refer to several interesting publications to find more information (Glasser et al. 2008; Samson et al. 2005; Nilsson 2003; Hall 1994).

Research Program

A research project was undertaken by the shotcrete team at Laval University to further investigate this subject. The experimental program put forward consists of the production and characterization of several concrete mixtures, both cast and sprayed. One objective of this study is to investigate the influence of shooting parameters and mixture characteristics on shotcrete BWA. This will allow for the optimization of mixture proportions, and for the understanding of the parameters that influence BWA. The shooting parameters investigated include the dry- and wet-mix processes and, in the case of dry-mix, the consistency and predampening were studied. The mixture characteristics studied were the aggregate gradation and the binder composition. The following section presents results regarding the influence of the air content, the cement paste volume, the aggregate gradation, and the water-cementitious material ratio (*w*/*cm*). A more detailed analysis and report can be found in Bolduc et al. (2010).

Results

It is difficult to control and study one specific parameter of shotcrete. Thus, to evaluate the influence of targeted mixture characteristics, several concrete mixtures were cast. Table 1 presents the mixture composition and Table 2 presents their fresh and hardened properties. In the mixture identification, the first term is the sand/stone ratio, the second term is the cement content (kg/m), and the last term is the targeted air content. The *w*/*cm* was kept constant within each study.

Air Content

The first investigated parameter was the air content. A priori, one can think that the more air bubbles are present, the higher the BWA will be. This is not the case. Indeed, it is shown in the literature (Fagerlund 1993) that if a concrete sample is immersed, the air void system does not saturate under normal atmospheric pressure. To verify this statement, two mixtures were cast; one with and one without an air-entraining admixture (AEA). From Table 2, one can observe that when the air content goes from 3.6 to 11.5%, the BWA only increases from 0.8%, which is not significant. Obviously, extended conclusions cannot be drawn from this study because only two mixtures were produced. This experimentation, however, shows that small variations of air content within mixtures will not significantly affect the BWA.

Aggregate Gradation

The second parameter studied is the influence of the aggregate gradation. It is shown in the literature that the interfacial transition zone (ITZ) between aggregates and the cement paste is more porous than the bulk paste (Neville 2000).

Table 2: Test Results

Study	Mixtures	Fresh properties		Hardened properties	
		Slump, in. (mm)	Air content, %	Compressive strength, psi (MPa)	Boiled water absorption, %
Air content	65/35-500-3	1-3/8 (35)	3.6	7498 (51.7)	5.8
	65/35-500-13	2 (50)	11.5	4931 (34.0)	6.6
Aggregate gradation	50/50-450-5	8 (200)	3.0	6193 (42.7)	6.5
	65/35-450-5	6 (150)	5.0	6773 (46.7)	6.6
	80/20-450-5	7-3/8 (188)	7.0	6222 (42.9)	6.5
Paste volume	65/35-390-5	2-3/8 (60)	6.0	6135 (42.3)	5.7
	65/35-450-5	6 (150)	5.0	6773 (46.7)	6.6
	65/35-530-5	9-1/4 (235)	2.0	6527 (45.0)	7.6

Accordingly, the hypothesis is that a finer aggregate gradation leads to a greater specific surface of aggregates, and thus to a larger volume occupied by the ITZ. Moreover, experience in the laboratory showed that mortar always absorbs more water. To verify this assumption, three mixtures were cast with sand/stone ratios of 50/50, 65/35, and 80/20 (refer to Aggregate gradation row in Tables 1 and 2). The other parameters were kept constant. Figure 5 presents the graph of the BWA against the aggregate gradation fineness.

The graph clearly shows that the aggregate gradation does not have a significant influence on the BWA. It seems that the porous ITZ is not reached by the water during a BWA test. Therefore, another explanation is needed to explain the higher BWA values obtained with mortars.

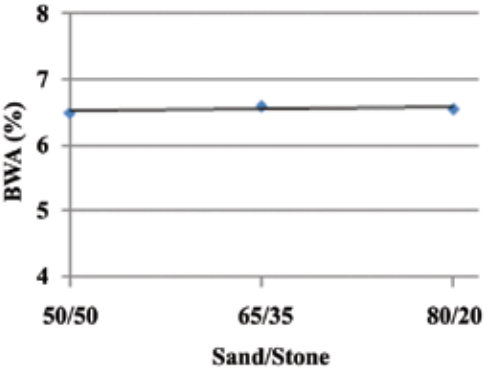


Fig. 5: Influence of the aggregate gradation

Paste Volume

In this study, the paste (or the cement paste) is considered as the product created by the combination of the water and the binder. It is often conveyed in the literature that shotcrete mixtures have a higher paste volume compared to conventional concrete. To evaluate the influence of the paste volume on concrete BWA, three mixtures were cast. The only variable parameter was the cement content: 24, 28, and 33 lb/ft^3 (390, 450, and 530 kg/m^3). The *w*/*cm* was kept constant, so the paste volumes were, respectively, 29.9%, 34.8%, and 42.3%. Figure 6 presents the graph of BWA as a function of the paste volume.

The graph shows that the correlation between these two parameters is practically linear; the higher the paste volume, the higher the BWA. The next step is obviously to produce shotcrete samples and verify how the aforementioned findings can apply to shotcrete.

w/*cm* ratio

The *w*/*cm* is the mass ratio between the amount of water in the mixture and the amount of cementitious materials (cement + supplementary cementitious materials). For conventional concrete, it is well known that this parameter affects the volume of capillary voids. For a given cementitious content, an increased amount of water will increase the capillary porosity, and consequently increase the BWA. To verify that this statement is still valid for shotcrete, 13 different mixtures were sprayed (both dry- and wet-mix) (Bolduc et al. 2010). The in-place *w*/*cm*, aggregate gradation, and paste volume were evaluated with the microwave method (Nagi and Whiting 1994). Figure 7 presents the BWA results as a function of the *w*/*cm*.

Taken globally, the results in Fig. 7 show a poor correlation between BWA and *w*/*cm*. The reader, however, can observe that when the three aggregate gradations used in the project are considered separately, the correlation greatly increases. The first gradation (ACI #1) is the one recommended by ACI Committee 506 (2005) for mortars. The second gradation (MTQ) is the granular distribution specified by the Ministry of Transportation of Quebec (Canada), somewhat located between gradations ACI #1 and ACI #2. The third gradation (ACI #2) is recommended by ACI Committee 506

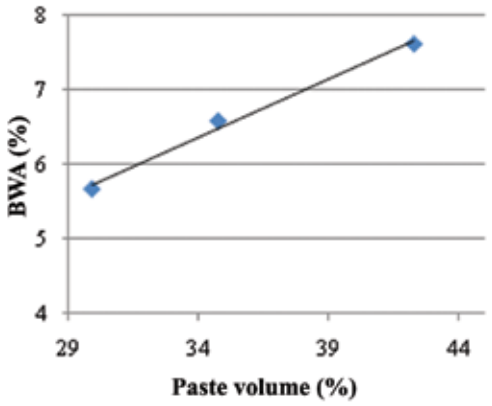


Fig. 6: Influence of the paste volume

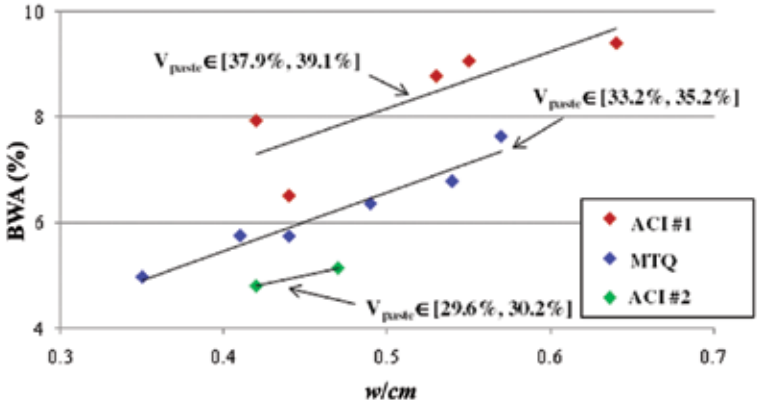


Fig. 7: BWA versus w/cm

(2005) for shotcrete containing coarse aggregates up to 3/8 in. (10 mm).

The graph shows that fine aggregate gradation (ACI #1) leads to higher BWA values (6.5 to 9.5%). The MTQ gradation brings BWA values that are between 5.0 and 7.5%, and the ACI #2 gradation leads to lower BWA values, which are around 5.0%. Because of the results presented in the Aggregate Gradation section, the aggregate gradation cannot be held responsible for the BWA variation between ACI #1, MTQ, and ACI #2 because it was shown that the fineness of the gradation does not influence the absorption.

To explain the difference between the three trend lines of Fig. 7, the paste volume must also be considered. Indeed, the in-place paste volumes from every mixture were compiled and an interesting conclusion was made. The ranges of in-place paste volumes are clearly distinct for every aggregate gradation. The ACI #1 gradation had the highest in-place paste volumes, ranging from 37.9 to 39.1%. The mixtures with MTQ gradation had in-place paste volumes from 33.2 to 35.2%, and the two mixtures with ACI #2 gradation led to paste volumes of 29.6 to 30.2%. In other words, a conclusion that can be drawn from these observations is that, in shotcrete, the initial aggregate gradation influences the in-place paste volume. The difference between the three trend lines is now easier to explain as it was shown in the Paste Volume section that the BWA is highly correlated with the cement paste volume.

More results and analyses were extracted from those 13 shotcrete mixtures. Details and further discussion can be found in Bolduc et al. (2010).

Discussion

Why is the BWA test specified?

Going back to the beginning of the paper, there is more than one answer to this question. Most would say that the BWA test is specified to assess the quality of the shotcrete placement. For example, it is commonly accepted in the industry that poorly compacted shotcrete, or material overdosed with set accelerator, will be identified with a BWA test. Some would also say that this test gives an idea of the shotcrete durability. Others suggest that it provides an indication of the overall shotcrete quality. Obviously, this is a topic that needs clarification.

The porosity measured in a BWA test mostly reflects the volume occupied by the capillary voids. Results presented in this paper show that mixtures with high paste volumes and high *w/cm* show an increased BWA, because a larger volume of voids accessible to water is present. In addition, other parameters are known to increase the volume of capillary voids, such as the use of porous aggregates and set accelerators. It is therefore clear that more than one parameter can affect the BWA of shotcrete, not only its placement. Is every parameter that increases BWA detrimental to the quality of shotcrete? The answer to this question is not necessarily. For example, Fig. 7 shows that three mixtures with a very good *w/cm* (0.45) can produce three very different values of BWA (5, 6, and 7.5%). These different BWA results are caused by the amount of paste present, not the quality of the paste itself.

Quality Indicators

In the 1980s, Morgan et al. (1987) compiled hundreds of BWA test from many shotcrete projects in North America. In their publication, the authors proposed quality indicators (Table 3) based on ASTM C642 results, which were used on various projects in Western Canada.

This classification system is very useful because it is simple and it can give, as its name reflects, a rapid appreciation of the overall shotcrete quality. Based on the results and discussion presented previously, however, it is clear that this indicator does not give a complete picture for all types of shotcrete mixtures. Moreover, based on the discussion surrounding the results found in Fig. 7, it seems that Table 3 should be adjusted to take into account the type of shotcrete produced (ACI #1 gradation as opposed to ACI #2 gradation).

Table 3: Morgan's Quality Indicators

Sprayed concrete quality	Permeable void volume, %	Boiled water absorption, %
Excellent	<14	<6
Good	14 to 17	6-8
Fair	17 to 19	8 to 9
Marginal	>19	>9

Conclusions

The main objective of this paper was to present new information regarding the BWA test in the shotcrete industry. A short review was presented in the first part of the article, where the three main transport mechanisms are briefly described: permeability, ionic diffusion, and capillary absorption. The second part of the article shares some results obtained from a recent study at Laval University. The main conclusions that can be drawn from this study are:

- The air content and the aggregate gradation do not directly influence shotcrete BWA;
- The paste volume and the *w*/*cm* both have a significant influence on shotcrete BWA; and
- Because of the placement process itself, the initial aggregate gradation affects the in-place paste volume, which in turn has an important effect on the absorption.

The authors consider that the BWA test is a quick and easy procedure to evaluate if the shotcrete microstructure was damaged or if the quality of the in-place material is affected. Owners and engineers responsible for the specifications, however, must clearly understand the different parameters that influence the BWA. High absorption does not necessarily mean poor quality shotcrete. Relevant specifications are crucial to guide contractors, but also to assure sound shotcrete applications.

References

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

ASTM C642, 2006, "Standard Test Method for Density, Absorption, and Voids in Hardened Concrete," ASTM International, West Conshohocken, PA, 3 pp.

ASTM C1202, 2005, "Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration," ASTM International, West Conshohocken, PA, 6 pp.

ASTM C1604, 2005, "Standard Test Method for Obtaining and Testing Drilled Cores of Shotcrete," ASTM International, West Conshohocken, PA, 5 pp.

Bolduc, L.-S.; Jolin, M.; and Bissonnette, B., 2010, "Evaluating the Service Life of Shotcrete," *Proceedings of the Third International Conference on Engineering Developments in Shotcrete*, E. S. Bernard, ed., Queenstown, New Zealand. (accepted for publication)

Fagerlund, G., 1993, "The Long Time Water Absorption in the Air Pore Structure of Concrete," Lund Institute of Technology, Division of Building Materials.

Glasser, F. P.; Marchand, J.; and Samson, E., 2008, "Durability of Concrete—Degradation Phenomena Involving Detrimental Chemical Reaction," *Cement and Concrete Research*, V. 38, pp. 226-246.

Hall, C., 1994, "Barrier Performance on Concrete: A Review of Fluid Transport Theory," *Materials and Structures*, V. 27, pp. 291-306.

Morgan, D. R.; McAskill, N.; Neill, J.; and Duke, N. F., 1987, "Evaluation of Silica Fume Shotcrete," *Proceedings of the International Workshop on Condensed Silica Fume in Concrete*, Montreal, Canada, 34 pp.

Nagi, M., and Whiting, D., 1994 "Determination of Water Content of Fresh Concrete Using a Microwave Oven," *Cement, Concrete and Aggregates*, V. 16, pp. 125-131.

Neville, A. M., 2000, Propriété des bétons, ed. Eyrolles, Paris, 806 pp. (in French)

Nilsson, L.-O., 2003, "Durability Concept: Pore Structure and Transport Processes," *Advanced Concrete Technology*, V. 2, Chapter 8, J. Newman and B. S. Choo, eds., Elsevier.

Samson, E.; Marchand, J.; Snyder, K. A.; and Beaudoin, J. J., 2005, "Modeling Ion and Fluid Transport in Unsaturated Cement Systems in Isothermal Conditions," *Cement and Concrete Research*, V. 35, pp. 141-153.

Louis-Samuel Bolduc *is a civil engineer with CEP Forensic Consulting Inc., a firm specializing in the field of forensic engineering and sciences. Over the last year, Bolduc has worked as a Research Engineer for the Research Center on Concrete Infrastructures in Quebec City. He has been involved in projects related to shotcrete compaction, service life prediction, and particle dynamics. He received his master's degree in civil engineering from Laval University, Quebec City, Canada. He is an associate member of ACI Committee 506, Shotcreting, and ACI Subcommittee 506A, Shotcrete—Evaluation.*

ASA Director and ACI member ***Marc Jolin*** *is an Assistant Professor in the Department of Civil Engineering at Laval University. He received his PhD from the University of British Columbia, Vancouver, BC, Canada, in 1999. An active member of CRIB, he is currently involved in projects on set accelerators, reinforcement encasement quality, new admixtures, and rheology of fresh shotcrete. Jolin is Secretary of ACI Committee 506, Shotcreting, and Chair of C660, Shotcrete Nozzleman Certification. His research interests include infrastructure durability and service life prediction.*

So what are you still waiting for?

It's time to get your nozzlemen trained and certified!

The American Shotcrete Association, in partnership with the American Concrete Institute, has developed a comprehensive program to upgrade the knowledge and skills of shotcrete nozzlemen and to facilitate ACI examination and certification. Provide your clients with the assurance that your nozzlemen have demonstrated that they have the capabilities to perform the job right—the first time!

To learn more or to schedule an ASA training session and an ACI Shotcrete Nozzleman Certification examination, visit www.shotcrete.org or call (248) 848-3780.

aci
American Concrete Institute®

AMERICAN SHOTCRETE ASSOCIATION

GUNITE.

Dry-mix done right.

Circle #47 on reader response form—page 68

GUNITE™
Supply & Equipment
www.gunitesupply.com

Northeast
4141 Airport Rd.
Cincinnati, OH 45226
Phone: 513.321.5526
Toll Free: 1.888.321.5526
Fax: 513.321.8178

West
1726 S. Magnolia Ave.
Monrovia, CA 91016
Phone: 626.359.9361
Toll Free: 888.393.8635
Fax: 626.359.7985

Southeast
9202 Meadow Vista Blvd.
Houston, TX 77064
Phone: 281.469.8097
Toll Free: 800.258.2421
Fax: 281.469.9524

Canada Line Cut and Cover Tunnel Shotcrete Shoring

Vancouver, BC, Canada

By Roger W. Abbott

Driving north from the Fraser River on the 4.3 mi (7 km) corridor of Cambie Street, a main artery into downtown Vancouver, one is oblivious to the fact that up to 72 ft (22 m) below the surface is one of the largest shotcrete shoring projects in North America—that of the new rapid transit Canada Line project (Fig. 1).

Originally called the RAV line (Richmond, Airport, Vancouver) from Vancouver International Airport to Downtown Vancouver, the $2 billion (Canadian) project was completed below budget and opened on August 17, 2009, 15 weeks ahead of schedule.

The challenges were great to make the project viable. Major sanitary and storm sewers and water mains within the building envelope had to be relocated clear of the work well ahead of time (Fig. 2). Fiber-optic cable, gas, and electrical lines also required diverting. Anchors were to be installed on both sides of the trench and shoring designed accordingly to miss the services by 3 ft (0.9 m), which was a real challenge at times. Over 26,000 tensioned anchors were installed along the route. Drillers were tense, especially drilling for the first two rows where services are usually encountered. Old services that had been abandoned due to relocation were frequently hit while drilling. Surveys of old services also proved useful in identifying potential problems.

The other limiting criterion was that anchors could not encroach on neighboring private property. This created some design challenges that, at times, required some innovative solutions. Shoring wall shotcrete had a ± 1 in. (25 mm) requirement to permit the use of the contractor's collapsible box formwork.

The soil types encountered along the route varied from running sands, silty sand, sandy silt, till, rock, peat, coal, old ravine infill, and anything in-between. Soil investigations, prior to designing the line, identified one area of high water table at a large intersection where a station was also to be constructed. Several deep 5.9 in. (150 mm) Φ wells were installed and frequently monitored and modified to lower the water table some 59 ft (18 m) to permit station construction and shoring in the area under relatively dry conditions.

Major intersections were laced with services crossing the trench, which had to be supported individually to eliminate the possibility of damage. It was here, especially, that the versatility of shotcrete had a major impact. Some vertical shoring elements were installed where horizontal anchors were impossible. Small shotcrete applications were normal until structures were all tied in, with much hand digging required.

Traffic bridges, pedestrian access bridges, and service supports had to be constructed ahead of

Fig. 1: The Canada Line project

Cambie Line Cut and Cover Facts

- 3.9 mi (6.2 km) of double-sided shotcrete shoring up to 70 ft (22 m) deep through a main street lined with retail and residential buildings
- 693,717 yd^3 (530,000 m^3) of excavation
- Approximately 19,634 yd^3 (15,000 m^3) 5075 psi (35 MPa) shotcrete
- 39,267 yd^3 (30,000 m^3) is rock at Little Mountain
- Over 1,076,000 ft^2 (100,000 m^2) of tieback anchored shotcrete shoring and underpinning
- Over 26,000 tensioned anchors
- 153,141 yd^3 (117,000 m^3) concrete
- 14,330 tons (13,000 metric tonnes) of steel

Fig. 2: Service support and congestion at cross street

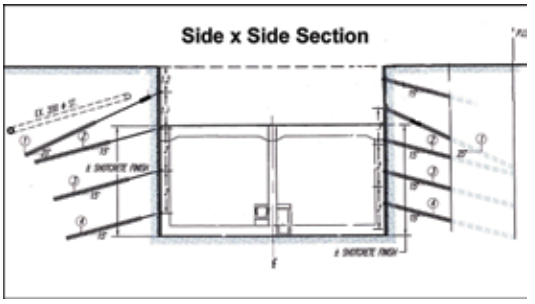


Fig. 3: Side-by-side section

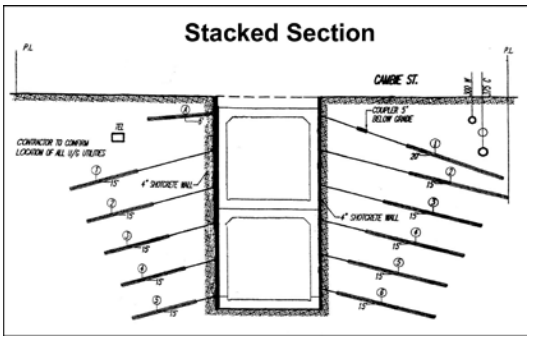


Fig. 4: Stacked section

the excavation and shoring work to provide uninterrupted traffic and pedestrian access. Through some of the sections, communications cable and fiber optics were slung along the side of the trench on hangers.

There were three different tunnel configurations: side-by-side in the wider sections where space would allow (Fig. 3, 6, and 7); stacked through the business section where access was smaller (Fig. 4 and 8); and a rollover section (a rollover is a transition from side-by-side to stacked) (Fig. 5 and 9). Through-traffic was maintained at all times on two of the four lanes along the entire length of Cambie Street (Fig. 10). The first section—64th to King Edward Avenue—comprised two southbound and two northbound lanes with a large grassed and treed central median. This section was where there was room to build the side-by-side structure. Trees were preserved with great care in the central median to try and eliminate any possibility of damage. Some of the flowering cherry trees and other species had been gifted to the city of Vancouver by the city of Yokohama on the occasion of the 1967 Canadian Centennial. Residents along Cambie Street created the Cambie Boulevard Heritage Society in 1994, which opposed any alteration to the wide green center median.

Configuration of the structure was:

- Side-by-side construction ..2.6 mi (4.24 km)
- Rollover transition from side by side to stacked.....0.5 mi (0.8 km)
- Stacked construction .....0.75 mi (1.2 km)

There were five stations along the cut-and-cover portion: 49th Avenue, 41st Avenue, 25th Avenue, Broadway (9th), and Olympic station at 2nd. From this point north, the twin tunnels were bored using tunnel boring machines (TBMs) underneath False Creek waterway to the downtown Vancouver core.

Construction began in December 2005 using the anchored shoring method commonly used in Vancouver. This system differs from the soil nailing system more commonly used in the U.S. and Europe. The soil nailing system was actually created in Vancouver in 1967 by Dr. Ted Mason, a local engineer.

A silica-based grout was used, as its high early strength (5802 psi [40 MPa] in 24 hours) allowed anchors to be tested the next day, which is essential to maintain the continuity of the shoring in coordination with the excavation. All anchored shoring panels were shotcreted the same day they were excavated. With the tensioned system, far fewer anchors are used, thereby making it a more economical system. Shotcrete was nominally 4 in. (100 mm) thick throughout the normal shoring wall. In areas where service avoidance resulted in greater than normal supported height, additional reinforcing and up to 8 in. (200 mm) of shotcrete was used, sometimes with vertical shoring elements such as micro piles. The underpinning of buildings around the stations was also 6 to 8 in. (150 to 200 mm) thick shotcrete. In a few limited areas where clearance to the property line was minimal, the soil nailing method was used.

The shotcrete used was a 5076 psi (35 MPa) mixture. Reinforcing of the shoring wall was one

layer of 4 x 4 in.-8/8 (102 x 102 mm–MW13.3/MW13.3) mesh with an additional layer of mesh at the anchor heads. In saturated and weaker soils, additional punching shear reinforcing was provided. A small area of the project was through rock, which was a fairly fragmented basalt. Anchors were greatly reduced in this area; and due to the uneven rock surface, which made contouring the mesh difficult, synthetic structural fibers were used at a dose of 7.25 lb/yd^3 (4.6 kg/m^3) instead of mesh with a 2 ft (600 mm) square of mesh only at the anchor head. Occasionally, silica fume was added to the mixture in tough, wet areas for additional adhesion.

Throughout the stacked section, where the width of the trench was only 17.5 ft (5.3 m) wide, drill masts were modified to fit within the trench. A modified tank drill was used in these sections; it was totally self-sufficient with its own air supply on board and didn't have hoses to drag through the mud. Drainage of the trench was very important, as Vancouver is renowned for its wet climate. Trenches were dewatered by sumps and pumps all along the route. The water was pumped to treatment plants along the route for cleansing prior to discharge into storm sewers. Various anchor types were used throughout the project

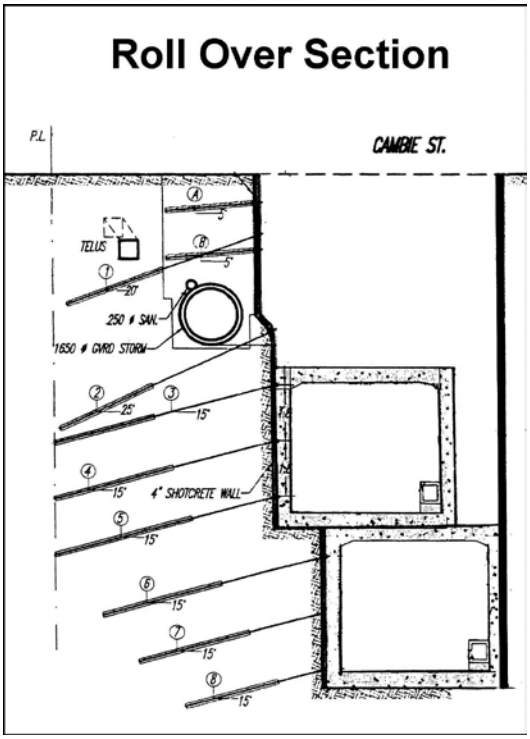


Fig. 5: Rollover section


Fig. 6: Side-by-side forms in place, with slab being prepared ahead


Fig. 7: Side-by-side forms being set


Fig. 8: Stacked section with pedestrian bridge


Fig. 9: Rollover section—start of tunnels transitioning to stacked

depending on the height of the cut. Solid-thread bar anchors were predominantly used; but in areas of pure sand and gravel, hollow grout-injected bars were used with great success. Along the very deep stacked section, areas of clay were encountered, resulting in some anchor failures. Each anchor was tested to confirm required capacity. Anchors could be redrilled or post grouted to achieve the desired capacity, leaving nothing to guess work. Every anchor that is tested is marked with a "T" for tested or "F" for fail as it is easy to lose track on a 3.7 mi (6 km) wall (refer to Fig. 7). Failed anchors were immediately replaced.

As the project got rolling and new areas with relocated services became available, the number of crews was increased to cope with the hectic pace of construction. Up to seven crews were working along the line on any given day. The procedure was:

Day 1: Excavate leaving a safe berm;
Day 2: Drill anchors though the berm;
Day 3: Cut and shotcrete first set of alternating panels;
Day 4: Tension previous day's anchors, cut, and shotcrete; and
Day 5: Tension last day's anchors and cut berm for the next level.

The process was repeated layer by layer.

Once at grade, the base slab was poured and the rolling formwork was set. There were four sets of 65.6 ft (20 m) long box forms that were cycled every 3 days (Fig. 8 and 9).

Shoring crews could see the advancing forming army and knew they had to act fast to get ahead. Survey control was by plumbing down from pre-surveyed control points, and with the tight tolerances, it was imperative to maintain accuracy of the vertical shotcrete wall. Waterproofing membrane was attached to the shotcrete wall in 3.3 ft (1 m) wide strips at the wall joints prior to pouring the concrete. This did not stop leaking entirely, however, and remedial grouting was performed on the soffits. In other areas, the minimal water ingress was merely collected in drainage channels at the edges of the structure and pumped out at the stations.

At the deepest stacked section (69 ft [21 m]) there were 11 rows of anchors. Looking up from the bottom of a narrow 17.4 ft (5.3 m) wide trench is quite an experience and calls for absolute faith in the designer.

Excavation of a 65.6 ft (20 m) deep by 17.4 ft (5.3 m) wide trench in the middle of active traffic and pedestrians presented a challenge (Fig. 11 and 12). Flaggers kept the traffic moving as fast as

Fig. 10: Buses can be seen passing on the right

Fig. 11: Long stick backhoe, fitted with camera on underside of the boom. Monitor is in the cab

Fig. 12: Camera to assist operator's vision of bucket

possible. Coordination was required during shotcreting to prevent blocking access for concrete trucks. Excavated material was recycled or loaded onto barges for ocean dumping at a federal government-approved dumping ground.

The same system of shoring was used for the five stations along the Cambie portion of the line, as they are all below grade. Some stations adjacent to existing buildings necessitated underpinning to shore up existing adjacent structures (Fig. 13).

Shoring was completed in July 2008 and the line opened 15 weeks ahead of schedule in August 2009 with up to 82,500 users daily in the first 6 weeks of operation.

For the designers, managers, and operators of the project for the next 35 years, it was a remarkable feat to overcome the major challenges this project presented, let alone to complete it on time and within budget. It is an example of what can be accomplished with the cooperation of all concerned and the team effort of all involved with the project. Decisions had to be, and were, made in a very timely fashion.

Visitors to the 2010 Olympic winter games, which commence on February 12 and end on March 21, will be the beneficiaries of this remarkable project, with direct links to the venues around Vancouver, Richmond, and the airport (Fig. 14).

Vancouver has aptly been called the "Shotcrete Shoring Capital of the World" because since the late 1960s, every building has been required to have a certain ratio of parking places per tenant. In 2005, Vancouver's density eclipsed that of Manhattan as North America's high-density residential area. Nearly all of the 85,000 downtown residents live in sleek high-rise towers filling the Vancouver skyline, most with up to eight levels of underground parking. The Pacific Centre Shopping Mall is completely underground in the center of downtown and extends four city blocks. Shotcrete shoring has been the excavation support system for the majority of these structures, as there is just not enough room to slope excavations. The flexibility of the shotcrete system has allowed successful completion of challenging projects, especially excavations along the waterfront where old rip rap berms, water ingress, and even buried locomotives have added to the challenge.

Fig. 13: Broadway Station: Note temporary bridge for vehicular traffic, which accommodated two lanes east and two lanes west along Broadway

Fig. 14: One of five completed Cambie Street stations

Canada Line Project

Owner/Operator
SNC–Lavalin

General Contractor
Cambie Street Constructors Ltd.

Shoring Contractors
Abbott Shoring & Foundations Ltd.
(49th to 2nd Avenue)
Southwest Contracting Ltd.
(64th to 49th Avenue)

Shoring Design
GeoPacific Consultants Ltd.

Roger W. Abbott *is President of Abbott Shoring & Foundations Ltd., whose main focus is shotcrete shoring, underpinning, and seismic reinforcement. He resides in North Vancouver and has 40 years of involvement with temporary and permanent shotcrete systems in the Pacific Northwest.*

Make Your First Choice the Right Choice

BarChip®

Synthetic Reinforcing Fibre

- REPLACE STEEL MESH AND STEEL FIBRE
- NO RUSTING ENSURING LONG TERM DURABILITY
- IMPROVE FIRE RATING
- REDUCE COSTS
- ENVIRONMENTALLY FRIENDLY
- SAFE TO HANDLE

epc
ELASTO - PLASTIC CONCRETE
www.elastoplastic.com

Australia	Call: +61 1300 131 158	australia@elastoplastic.com
Asia	Call: +65 6835 7716	asia@elastoplastic.com
North America	Call: +1 704 843 8401	na@elastoplastic.com
South America	Call: +56 32 271 5118	sa@elastoplastic.com
Europe	Call: +44 (0)77 8070 2642	europe@elastoplastic.com

ASIA PACIFIC ■ EUROPE ■ NORTH AMERICA ■ SOUTH AMERICA

Circle #3 on reader response form—page 68

ACI's Shotcrete Nozzleman Certification Program Arrives in Asia

Shotcrete is used on many projects in Asia today. Currently, however, there are no governing standards for assessing the quality of the shotcrete applied and the workmanship employed during the shotcreting process. It is also not uncommon for shotcrete nozzlemen to be replaced more than once during a single project and, in fact, none of them are required to have any form of certification.

The Society of Rock Mechanics and Engineering Geology Singapore (SRMEG), with the support of the Building and Construction Authority Singapore (BCA), proudly introduced Singapore's first ACI Shotcrete Nozzleman Certification Program in October this year. Conducted by Associate Professor Marc Jolin, an ACI-approved Shotcrete Nozzleman Examiner and ASA Educator, and SRMEG, this program was an important milestone for the construction industry in Singapore and Asia. Prior to this event, the ACI Shotcrete Nozzleman Certification Program had never been conducted in Asia. The program was held October 7-9, 2009, and was attended by 10 nozzlemen from six companies. All who attended were experienced nozzlemen with at least 500 hours of experience with wet-mix shotcrete hand nuzzling. Participants came from countries around the region (Thailand, Australia, Hong Kong, the Philippines, and Singapore), which has created the opportunity for Singapore to become a center of shotcrete excellence in Asia.

Fig. 1: The participants listening to Associate Professor Marc Jolin

No certification program can address all potential variables; but the ACI Shotcrete Nozzleman Certification ASA Education Program aimed to provide the nozzlemen with improved shotcreting knowledge and skills and, more importantly, international recognition as professional craftsmen. Upon successful completion of the program, the nozzlemen's certificate is valid for 5 years. It will be beneficial for projects to employ ACI-certified shotcrete nozzlemen, which assures shotcrete

Fig. 2: (from right to left) Yang Kin Seng (BCA), Vice-President of SRMEG; Associate Professor Marc Jolin; SRMEG Shotcrete subcommittee members; and the participating nozzlemen

Fig. 3: Associate Professor Marc Jolin conducting the training session

Fig. 4: Nozzleman participating in the vertical performance examination

Fig. 5: Participating nozzlemen after the vertical and overhead spraying sessions

Fig. 6: Nozzleman coring the test panels

specifiers (or consulting engineers) that the nozzleman has the required professional knowledge and capabilities to properly apply shotcrete.

Working Timeline

May 5, 2009, to October 5, 2009—The Shotcrete Subcommittee, comprising Gan Cheng Chian, Ong Perng Fey, and Lee Kah Fai of SRMEG, worked to bring the ACI Shotcrete Nozzleman Certification Program from North America to Singapore.

October 6, 2009—Jolin from Laval University, Quebec City, QC, Canada, gave a seminar on the ACI Shotcrete Nozzleman Certification Program at the Shaw Foundation Alumni House in Kent Ridge. The seminar aimed to inform people in the construction industry about the aforementioned program in greater detail.

October 7, 2009—Ten shotcrete nozzlemen from around Asia attended an ACI Shotcrete Nozzleman Certification session. The session was conducted by Jolin, an ASA-approved Educator.

October 8, 2009—Jolin, an American Concrete Institute (ACI)-approved Examiner, conducted the certification testing. The 10 shotcrete nozzlemen had to complete a written examination before going to a site for the performance examination that required shooting/spraying vertical and overhead panels using wet-mix shotcrete. By 6:30 p.m., all of the nozzlemen had completed the written and performance examinations of the ACI Shotcrete Nozzleman Certification Program.

October 9, 2009—Jolin and a team of concrete coring specialists proceeded to core five concrete cores from each shotcreted panel. By 5:00 p.m., all coring was completed and all cores were examined and assessed by Jolin.

The following individuals are the first shotcrete nozzlemen in Asia to pass the ACI Shotcrete Nozzleman Certification for both vertical and overhead positions in the wet-mix category:

- Lim Choon Teck (Singapore) from Tunnel and Shaft Pte Ltd;
- Lee Kah Fai (Singapore) from Tam International Pte Ltd;
- Ritchard Hood (Hong Kong) from Tam International Pte Ltd;
- Steven Tan Boon Peow (Singapore) from SembCorp Design and Construction Pte Ltd;
- Tun Thein Naing (Myanmar) from SembCorp Design and Construction Pte Ltd;
- Alve Kjell Robert Rutgersson (Australia) from Tam International Pte Ltd;
- Kachagorn Sakuna (Thailand) from Right Tunnelling Co., Ltd; and
- Ramir Navarro Cagot (Philippines) from Normet International Ltd.

The following individual is the first shotcrete nozzleman in Asia to pass the ACI Shotcrete Nozzleman Certification for vertical application in the wet-mix category:

- Chayanatthapon Khoonchan (Thailand) from Right Tunnelling Co., Ltd.

SRMEG, with the support of BCA, will be conducting Singapore's second ACI Shotcrete Nozzleman Certification Program in March 2010.

Reprinted with permission from the Spring 2007 issue of Shotcrete *magazine*

SAFETY SHOOTER

Forming: A Balance Act

By Chris Zynda, Director of Shotcrete Operations, Joseph J. Albanese, Inc., ASA President and Safety Committee Chair

The use of shotcrete for wall construction is becoming more popular every day as an alternative to cast-in-place walls. The forming systems being used for shotcrete walls are many in design, from metal to wood to others, but all have one very important safety concern: when they become tall, they can become unstable if the weight of the reinforcing bar and shotcrete is not properly taken into consideration when designing the forming system (Fig. 1).

The weight of the reinforcing bar is a major concern. The only thing that keeps it in place is the support of the forming system. A shotcrete form that is not braced properly could fail, falling backward or even forward toward the shotcrete crew, creating a major safety risk.

Figure 2 shows a shotcrete wall near completion. Now let's add the weight of the shotcrete to the weight of the reinforcing bar and consider the balancing act involved. If the form in Fig. 2 was not properly braced and fell forward, look at the danger to the crew below and the workers on the scaffolding.

Tall forms may need steel pipe braces to the inside to support the mass of reinforcing bar and shotcrete from overturning forces. This bracing needs to be placed strategically so that it does not hinder the shotcrete operation (Fig. 3). To help keep the bracing in place on the back side of the form, concrete dead men may be needed to help hold the bracing stable so there is no overturning of the installed system, including the reinforcing bar and shotcrete (Fig. 4).

Safety Tip: Always consult an engineer when designing any forming system.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Have YOU Visited the ASA Web site Lately?

There have been significant changes and new services added!

FEATURES —

- ASA Buyers Guide
- Technical Inquiry Submission
- Shotcrete Video Demos
- *Shotcrete* Magazine Archive
- Outstanding Shotcrete Project Awards
- Products
- Education
- Certification
- And Much More

AMERICAN SHOTCRETE ASSOCIATION

WWW.SHOTCRETE.ORG

Special Shotcrete Inspection in Swimming Pool Construction

By Ron Lacher

I am writing this article just having returned from 4 very busy days at the ACI Fall 2009 Convention in New Orleans, LA. During those 4 days, I attended all of the American Shotcrete Association (ASA) committee meetings as well as the committee meetings for ACI Committees 506, Shotcrete, and C660, Shotcrete Nozzleman Certification. The experience was more than worthwhile. The new people I met and contacts I made were invaluable, some when least expected. I struck up a conversation with the gentleman in front of me in the cab line at the New Orleans airport. It turned out that he was a materials engineer involved in a case I was researching for an issue I'd run into. What a coincidence! I plan on writing about this important issue in a future article for *Shotcrete* magazine. Especially beneficial was hearing first-hand about all the projects and activities in progress by the committees and subcommittees dealing with shotcrete. Plus, I thoroughly enjoyed visiting New Orleans and experiencing its unique history, architecture, and culture. Did I mention the food? I had more than my share of gumbo, red beans and rice, and poboys. If you are in the swimming pool industry and have an interest in shotcrete, I encourage you to attend the ASA committee meetings at the ACI Spring 2010 Convention in Chicago, IL, March 20 to 25. The swimming pool industry is one of the most visible users of shotcrete and more representation is needed in both ASA and ACI.

Shotcrete inspection would help eliminate many unacceptable practices such as making steps and benches with rebound

Of the various committee meetings I attended while in New Orleans, I found that ACI Committee C660 was working on what I believe to be one of the most important topics in shotcrete today—Shotcrete Inspector Certification. As readers of *Shotcrete* magazine, we already know that shotcrete is a very versatile and economical method of concrete placement. As with any construction method, we also know that there are a number of important aspects necessary to obtain quality results. Many articles have been written about most of those aspects, for example, the knowledge, skill, and experience of the nozzleman. There are other aspects of shotcrete application that, in my opinion, are almost as important as the skill of the nozzleman. Those are the knowledge and training of the shotcrete inspector. Today, most areas of the country have adopted the International Building Code (IBC) published by the International Code Council (ICC). In Chapter 17, Table 1704.4, of the IBC, continuous shotcrete inspection for proper application techniques during shotcrete placement is required. Many swimming pool contractors are not familiar with the code requirement for shotcrete special inspection because the Code makes an exception for most residential pools (Group R-3 and U occupancies). Even so, it is not uncommon for the local building official to require continuous special inspection during shotcrete placement in swimming pools.

These types of requirements tend to proliferate so, as time goes on, more and more building departments will likely require continuous special inspection during shotcrete placement in swimming pools.

When continuous shotcrete inspection is required in swimming pool construction, what category of inspectors performs the inspection and where do the inspectors get their knowledge and training about shotcrete placement? Continuous shotcrete inspection is usually provided by an independent special inspector who typically possesses some form of certification in concrete inspection either from ACI or perhaps ICC. Holding an ICC or ACI certification, however, doesn't guarantee that the inspector is familiar with the code inspection requirements for shotcrete placement.

Let's take a quick look at the two ACI certification programs that would be relevant to structural concrete testing and inspection. The first is called *Concrete Field Testing Technician—Grade I*. According to ACI, this is an individual who has demonstrated the knowledge and ability to properly perform and record the results of seven basic field tests on freshly mixed concrete. The seven basic field tests are: 1) the temperature of freshly mixed portland cement concrete; 2) sampling freshly mixed concrete; 3) slump of hydraulic cement concrete; 4) unit weight, yield, and air content of concrete; 5) air content of freshly mixed concrete by the pressure method; 6) air content of freshly mixed concrete by the volumetric method; and 7) making and curing concrete test specimens in the field. Of course, these are important tests and one or more may be performed as a part of the placement of wet-mix shotcrete materials. But these tests do not relate in any way to proper shotcrete application techniques nor are they applicable to dry-mix shotcrete. The second ACI certification program is called *Concrete Construction Special Inspector*. This is a person qualified to inspect and record the results of concrete construction inspection based on codes and job specifications and includes pre-placement, placement, and post-placement operations. ACI's knowledge requirements for this certification include a long list of resource materials, but it's noteworthy that this list does not include any resource materials about shotcrete. The ICC *Reinforced Concrete Special Inspector* is an individual who possesses one of the two aforementioned ACI certifications and has also passed the ICC special inspector exam that tests for knowledge of concrete quality, reinforcement, formwork, joints and embeds, concrete placement, protection, and curing. Similarly to ACI's required knowledge base, ICC did not list shotcrete as a content area for the ICC exam. Based on this and as previously stated, holding an ICC or ACI certification does not guarantee that the inspector is familiar with the code inspection requirements for shotcrete placement.

My experience with shotcrete special inspection is primarily related to swimming pool construction, and my comments are not intended to reflect on special shotcrete inspectors outside of swimming pool construction. Also, I'm sure that there are many capable and knowledgeable special inspectors in swimming pool construction. I've had personal experience, however, with many inspectors who did not have a clear understanding of the proper methods of shotcrete application and testing. One area where there is considerable confusion is the obtaining of shotcrete samples for compression testing. The IBC requires, under Paragraph 1913.10.1, Sampling, that shotcrete specimens be taken from the in-place work or from test panels. Variations actually used include shooting into a homemade welded wire basket formed into a cylinder, taking wet-mix shotcrete samples directly from the ready-mix chute and rodding into a standard test cylinder, and taking either shot or unshot dry-mix material and rodding into a standard test cylinder. Clearly, these alternate methods of obtaining samples for testing do not meet the intent of the IBC. Other areas where proper shotcrete application does not appear to be well understood by some shotcrete special

Shotcrete inspection would eliminate many unacceptable practices such as packing rebound around skimmers

inspectors include the proper angle of the nozzle to the receiving surface; the removal of rebound and overspray on the receiving surface; the improper reuse of rebound; and the improper phasing of the work, especially in wet-mix applications where walls are often shot before the floor at the base of the wall.

Based on my experience and observations in the swimming pool industry, it is my opinion that independent special shotcrete inspection is an area where improvement in knowledge and training is needed. Are these examples isolated instances of special inspectors not providing the oversight that was expected of them? Sadly, many shotcrete applicators in swimming pool construction have, "off the record," voiced similar experiences.

I'm not one who believes in establishing rules and procedures to solve potential problems when those potential problems have never occurred, but that is not the case with training and certification of shotcrete inspectors. As previously mentioned, ACI Committee C660, Shotcrete Nozzleman Certification, is currently developing a certification program for special shotcrete inspectors. Based on my experiences, a couple of which I've outlined herein, I'm strongly in favor of certification for shotcrete inspectors based on a training and certification program developed by ACI Committee C660. I hope to become involved in that process.

***Ron Lacher**, PE, CBP, President of Pool Engineering, Inc., received his bachelor's degree in civil engineering. Lacher is a nationally recognized expert in swimming pool construction and swimming pool structural design. He is a Certified Building Professional (CBP) by The Association of Pool & Spa Professionals (APSP). His firm, Pool Engineering, Inc., has provided the structural designs for over 100,000 pools. Lacher's affiliations include the Advisory Board of the National Pool Industry Research Center, California Polytechnic State University, San Luis Obispo, CA; the APSP Builders Council and Education Committee; the ASA Pool Recreational Shotcrete Committee, where he is an approved educator for wet- and dry-mix shotcrete; the International Association of Plumbing & Mechanical Officials technical committee for the Uniform Swimming Pool, Spa & Hot Tub Code; and The Ceramic Tile Institute of America Swimming Pool technical subcommittee for the preparation of ANSI installation standards for tile and glass tile in swimming pools. Lacher has authored numerous articles on proper trade practices and structural engineering in swimming pool construction and is a well-known seminar presenter at national and regional trade conferences. He is a licenced professional engineer in California.*

***Tom Norman**, ASA member and Chair of ASA's Pool & Recreational Shotcrete Committee, wants your input. Your comments, suggestions, and the topics you'd like to see covered are welcome. Perhaps you'd like to become a contributing author to Pool & Recreational Shotcrete Corner. Norman and the ASA staff encourage you to contact ASA with your questions and comments at: info@shotcrete.org.*

Shotcrete Calendar

FEBRUARY 1, 2010
ASA World of Concrete Annual Meetings
Las Vegas Convention Center
Las Vegas, NV
Publications Committee
8:00 a.m.-9:00 a.m., Room S225
Pool & Recreational Shotcrete Committee
9:00 a.m.-10:00 a.m., Room S225
Education Committee
10:00 a.m.-11:00 a.m., Room S225
Safety Committee
11:00 a.m.-12:00 p.m., Room S225
Marketing & Membership Committee
12:00 p.m.-2:00 p.m., Room S225
Underground Committee
2:00 p.m.-3:00 p.m., Room S225
Sustainability Committee
3:00 p.m.-4:00 p.m., Room S225

FEBRUARY 1-5, 2010
World of Concrete
Visit ASA at booth S10749
Seminars: February 1-5
Exhibits: February 2-5
Las Vegas Convention Center
Las Vegas, NV
Web site: **www.worldofconcrete.com**

FEBRUARY 2, 2010
Using the Shotcrete Process to Rehabilitate North America's Infrastructure Seminar
8:30 a.m.-10:00 a.m.
Las Vegas Convention Center
Las Vegas, NV
Web site: **www.worldofconcrete.com**

FEBRUARY 2, 2010
The 2010 ASA Annual Membership Meeting & Fifth Annual Outstanding Shotcrete Project Awards Banquet
Reception: 6:00 p.m.-7:00 p.m.
Dinner: 7:00 p.m.-10:00 p.m.
Monte Carlo Resort & Casino
Las Vegas, NV
Web site: **www.shotcrete.org**

MARCH 15-17, 2010
Australian Shotcrete Society's International Conference/Engineering Developments in Shotcrete
Millennium Hotel
Queenstown, New Zealand
Web site: **www.eds2010.com**

MARCH 20, 2010
ASA Spring Committee Meetings
Sheraton Chicago
Chicago, IL

MARCH 21-25, 2010
ACI Spring 2010 Convention
Theme: "Xtreme Concrete"
Sheraton Chicago
Chicago, IL
Web site: **www.concrete.org**

MARCH 22, 2010
ASA Spring Underground Committee Meeting
Sheraton Chicago
Chicago, IL

APRIL 14-16, 2010
ICRI 2010 Spring Convention
Theme: "Aesthetics in Concrete Repair"
Myrtle Beach Resort & Spa at Grande Dunes
Myrtle Beach, SC
Web site: **www.icri.org**

JUNE 6-9, 2010
ASTM International Committee C09, Concrete and Concrete Aggregates
Renaissance St. Louis Grand and Suites Hotel
St. Louis, MO
Web site: **www.astm.org**

JUNE 6-9, 2010
International Bridge Conference
Pittsburgh, PA
Web site: **www.eswp.com/bridge**

OCTOBER 20-22, 2010
ICRI 2010 Fall Convention
Theme: "Transportation Structures"
Omni William Penn Hotel
Pittsburgh, PA
Web site: **www.icri.org**

OCTOBER 28 - NOVEMBER 2, 2010
2010 AASHTO Annual Meeting
Beau Rivage Resort & Casino
Biloxi, MS
Web site: **www.transportation.org**

DECEMBER 5-8, 2010
ASTM International Committee C09, Concrete and Concrete Aggregates
Sheraton New Orleans
New Orleans, LA
Web site: **www.astm.org**

2008 Outstanding Infrastructure Project

Abraham Lincoln Memorial Bridge




The Abraham Lincoln Memorial Bridge, located in LaSalle, IL, is the longest bridge in the state, with a total length of 7122 ft (2170 m) and supported by 86 piers, 43 in each direction. The bridge is elevated approximately 70 ft (21 m) above the Illinois River and numerous local roads, lakes, wetlands, and railroads. The piers range from 50 to 100 ft (15 to 30 m) high and are 41 ft (12.5 m) wide and 4 ft (1.2 m) thick at the caps, but increase to 6 ft (1.8 m) at the base. The piers span between 135 and 165 ft (41 and 50 m).

Shotcrete Challenge

The bridge was repaired in two phases. The southbound repairs began in 2007 and the northbound in 2008. The general contractor removed and replaced some 22,000 yd^3 (16,820 m^3) of concrete on the bridge deck alone. The shotcrete contractor was contracted to repair the substructure following the Illinois Department of Transportation Structural Repair of Concrete Specification. The specification gives the contractor the choice of formed concrete repair or shotcrete.

Access to the piers below was severely limited to a 10 ft (3 m) area adjacent to live traffic while access on the ground was limited to only a handful of piers, which were inaccessible as they were surrounded by the Illinois River, wetlands, lakes, and the historic Illinois-Michigan canal. The substructure repairs were delayed until July 10, 2007, so the general contractor could replace the first 600 ft (183 m) of bridge deck because the 10 ft (3 m) access lane was deemed unsafe and a potential hazard next to live traffic.

Plan of Attack

For the piers that were surrounded by land, 70 ft (21 m) tall boom lifts were placed over the side of the bridge with cranes. As concrete removal started, it was immediately recognized that the project was going to exceed initial contract quantities. This required evaluation and authorization by the owner. This time delay for approval was used constructively by engineering a safe way to raise and lower platforms that were placed just below the deck by the general contractor, which extended 50 x 6 ft (15 x 1.8 m) with a mass of 6000 lb (2722 kg). These platforms were to be used at all finger joint piers over the river, lakes, and wetlands that were inaccessible.

A quick response from the owner in the first week of August 2007 was received for the approval of additional quantities and concrete removal was set in motion at numerous piers. The concrete was removed past the first mat of steel while saw-cutting the edges and sandblasting using abrasive grit, taking great care to blast the saw-cut edges that were to be polished with the saw cut. Black reinforcing bar was supplemented as necessary and then the entire prepared area was inspected by the engineer for approval.

Shotcrete Solution

All of the shotcrete work was performed from the bridge deck, including the deliveries of prebagged materials. The water was hauled on site using 250 gal. (946 L) totes and the temperature was monitored. The use of hot water in tote tanks in cool weather and the use of ice in warmer weather kept the material temperature consistently

between 70 and 78°F (21 and 26°C). In addition, the use of canopies over the material and shotcrete pump aided in temperature control during the summer months while concrete blankets and heaters helped moderate the material temperature in autumn 2007 and spring 2008.

The freshly sandblasted surface (within 72 hours of shotcrete placement by specification) was pre-wet to a saturated surface-dry condition. The shotcrete was placed with 0.42 water-cement ratio (*w/c*), along with the addition of 10% by weight of 3/8 in. (9.5 mm) river rock. All of the work was completed by ACI certified nozzlemen. The curing was done with cotton mats attached to the pier with 1 x 2 in. (25 x 50 mm) studs and interspersed with heavy-duty soaker hoses and gravity fed with water for 7 days. After 7 days of wet curing, the mats were removed; and the structures were sounded by the engineer for acceptance.

Phase I (southbound) was completed mid-November 2007 and Phase II (northbound) was completed August 29, 2008. The scope of work resulted in over 15,000 ft^3 (425 m^3) of removal and replacement with high-quality shotcrete. The general contractor and the subcontractor are also proud of their safety record of zero accident reports while working 80 ft (24 m) in the air. All of the test results exceeded the specification's requirement. The shotcrete solution resulted in a long-term, affordable repair.

As in all highway projects, time is of the essence. The use of shotcrete and its versatility had many advantages compared with form and pump. One example was the ability to remove concrete on the piers in segments. On several piers that were severely deteriorated, 33% of the pier was repaired using shotcrete and was remobilized after it reached 70% of its strength. The procedure was then repeated. This eliminated any concern for destabilization of the structure. The placement of a prebagged shotcrete material allowed a freshly placed, quality-adjusted consistent mixture.

Concrete that would have been used in formwork would have a short open time to work with after transit time from the plant. There would have also been the risk of form blowout and polluting the wetlands. Shotcrete was also chosen for safety reasons. The air and water hoses going over the side offered considerably less risk than lowering and manhandling lumber in the mass quantities that would have been required. Also, if a problem occurred with concrete placement in the middle of a patch that was unreachable, it would require removal of the form.

The shotcrete placement by ACI certified nozzlemen could be completed the following day with sandblast or high-pressure water blasting of the edge of the patch. The shotcreting process allows a visual encapsulation of the reinforcing steel. Pumping blindly into formwork could result in voids if proper compaction efforts were not exercised. The curing of shotcrete by use of wet cotton mats was superior to a form left in place.

Safety, time, quality, and money concerns all significantly contributed to the use of shotcrete by the Illinois Department of Transportation on the Abraham Lincoln Memorial Bridge.

Outstanding Infrastructure Project

Project Name
Abraham Lincoln Memorial Bridge

Project Location
LaSalle, IL

Shotcrete Contractor
American Concrete Restorations, Inc.*

General Contractor
Civil Constructors

Architect/Engineer
Illinois Department of Transportation

Material Suppliers
U.S. Concrete Products, LLC*
Spec Mix, Inc.* as manufactured by Packaged Concrete, Inc.
Allentown Shotcrete Technology, Inc.*

Project Owner
Illinois Department of Transportation

*Member of the American Shotcrete Association

Is There Fly Ash in Your Future?

By Thomas H. Adams

Those familiar with concrete materials technology are very comfortable with using fly ash as an important supplementary cementitious material (SCM). Improved ultimate compressive and flexural strengths, reduced permeability, and mitigation of alkali-silica reactivity problems are just some of the more widely appreciated benefits. Decades of research and field experience have established fly ash as an important tool in creating more sustainable concrete construction projects.

The U.S. Environmental Protection Agency (EPA), however, may change how the concrete industry regards the use of fly ash going forward. A breach of containment at the Tennessee Valley Authority's Kingston, TN, facility in December of 2008 resulted in 5.5 million yd^3 (4.2 million m^3) of coal ash spilling into the surrounding properties and into the Emory River. No serious injuries or deaths resulted from the breach. Four homes were severely damaged or destroyed. In response, Senator Barbara Boxer asked Lisa Jackson, President Obama's nominee as EPA Administrator, to review the Kingston event and develop regulations for coal combustion product (CCP) disposal. (Currently, there are no federal

regulations for disposal of CCPs.) Jackson made a commitment to propose regulations by the end of 2009.

The EPA can elect to create a regulation under either Subtitle C or Subtitle D of the Resource Conservation and Recovery Act (RCRA) of 1976. Subtitle C is used for "hazardous wastes" and is enforced by the federal government. Subtitle D is used to regulate nonhazardous wastes such as municipal solid waste and is administered by individual states. Should EPA choose the Subtitle C option, fly ash would be considered a "hazardous waste" for disposal purposes. One option discussed for some months would be a "hybrid" approach under which fly ash sent to disposal would be treated as a hazardous waste, but fly ash used in cement and concrete would not be considered hazardous. According to engineers, contractors, concrete producers, and owners contacted by the American Coal Ash Association (ACAA), this designation for disposal would create a stigma associated with fly ash and cause the industry to turn away from using fly ash for fear of tort exposure for use of a "hazardous waste" in a concrete construction project. The concern is that if fly ash is a hazardous waste when being placed in a landfill, it must be hazardous when used to produce concrete. Getting a jury to make that connection would be fairly easy, according to attorneys who have considered this scenario.

The memory of the litigation known as the "Sulfate Wars" in Southern California only a few years ago is still very fresh. No damage needs to be proven to have waves of litigation coming at any party connected to a project. In regard to the stigma of using a "hazardous waste" in concrete, the best and only way to stay out of court is to refrain from specifying, buying, producing, or owning concrete containing fly ash.

It is interesting that the EPA made determinations in 1993 and 2000 that CCPs did not warrant regulation as a hazardous waste. To date, there has been no new evidence produced to support a reversal of those determinations. The agency must include its risk assessment when the proposed rule is announced. It will be interesting to see the justification for any kind of a Subtitle C rule.

The EPA has stated publically on numerous occasions that the use of fly ash in cement and concrete production is a beneficial use the agency supports. However, the agency does not believe the stigma issue is a real threat to continued use. The ACAA believes the problem with disposal of CCPs can be handled without destroying the beneficial uses of these materials. Industry and numerous state agencies have advised the EPA on how this can be done. If the agency elects to ignore this advice, some startling impacts will include the following:

- the 44% of the 130 million tons of CCPs currently used for beneficial uses will most likely be sent to disposal;
- 15 million tons of CO_2 emissions avoided by use of fly ash in concrete production will be emitted into the atmosphere; and
- concrete durability will take a major step backwards.

As this article is being written in December 2009, release of a proposed rule is expected by the end of the year. The proposal will be published in the Federal Register as an Advance Notice of Rule Making. Following publication, there will be a public comment period lasting somewhere between 30 and 90 days.

For more information on this issue, please contact the ACAA at info@acaa-usa.org.

Thomas H. Adams *is the Executive Director of the American Coal Ash Association. The American Coal Ash Association, headquartered in Aurora, CO, was founded in 1968 to promote the beneficial use of coal combustion products in ways that benefit the environment, the economy, and society.*

What's Wrong with This Shotcrete Material? It's Not Bonding!

It was Good Yesterday but Today It's Not Sticking

By Michael Cotter

Before you automatically call to scream at the manufacturer, you may want to check a few things that you, as the contractor, may be doing wrong in your daily operations, regardless if you are using the wet or dry method of shotcrete placement.

First, let's begin with the water. Check to make sure it is fresh and from a potable source. You may want to check the temperature of the water as this will definitely affect the mixture. Next, check all the fluid levels on the compressor, especially the air end oil. When you start the compressor, make sure to build to operating temperatures and inspect all lines for leaks. Bleed the moisture by slowly opening a valve. Check to make sure the compressor is not blowing oil by holding an 8 x 11 in. (203.2 x 279.4 mm) piece of cardboard in front of the valve and slowly turning the air three quarters of the way on with the air stream directed at the cardboard. If you notice an oily substance on the cardboard, oil is entering the air stream, which is ultimately entering the shotcrete mixture at either the dry gun or the nozzle on the wet mixture.

What happened? What did I do? What happened is either there is a collapsed oil/air separator or it is in need of replacement. The life of the oil separator element is dependent upon the operating environment (for example, dust and soot) and should be replaced every 12 months or 2000 hours, per the manufacturer's recommendation. Remember, most compressor manufacturers recommend the oil/water separator be replaced every 500 to 1000 hours under normal working conditions. Shotcreters, however, typically don't work under normal conditions. We run hard. We run the equipment hard. That is the nature of the business.

A few tips to shut down the compressor are 1) do not allow the employees to use the compressed air to blow themselves off at the end of the shift; 2) do not run the compressor with valve(s) open to the atmosphere; 3) do not shut the compressor off with the valve(s) open; and 4) do not shut the compressor off and then open the valve(s) to bleed the air. Allow the compressor to bleed the air itself and slowly.

If you notice sheen in the shotcrete, it is probably from the delivery system. If you noticed this problem before and overlooked it but now are noticing a pattern of "bad" material, do the industry a favor. Investigate how long you've had this problem. Check your work by sounding out the repair area and removing all unsound concrete and properly preparing the surface prior to replacement. Develop a toolbox talk from the compressor manufacturer's equipment manual. Proper training on equipment will avoid many potential shotcrete failures.

Michael Cotter *is a former member of the Gunite Contractor's Association, Charter Member and Treasurer of the American Shotcrete Association, and an ACI-certified nozzleman. He is involved in the shotcrete industry, both wet- and dry-mix processes. Cotter was instrumental in helping develop the use of hydrodemolition for overhead and vertical locations in the early 1980s. Cotter is a consultant currently promoting shotcrete in the rail and road transportation arenas. His motto is "There is enough concrete to repair without the need to do it over." Cotter can be reached at mpccotter@aol.com.*

ASA New Members

CORPORATE MEMBERS

Advanced Shotcrete, Inc.
Salt Lake City, UT
Primary Contact: Therin Ramos
therin@advancedshotcrete.com
www.advancedshotcrete.com

Donald J Scheffler's Construction
City of Industry, CA
Primary Contact: Donald J. Scheffler
mailbox@heidicorp.com

Hardcore Shotcrete Skateparks Inc.
Joplin, MO
Primary Contact: Mark Leone
info@hardcoreskateparks.com
www.hardcoreskateparks.com

Mid American Gunite Pools, Inc.
Covington, KY
Primary Contact: Patrick M. Brennan
pool1boss@fuse.net
www.midamericanpools.com

Pacific Alloy Casting Company, Inc.
South Gate, CA
Primary Contact: Mark Regus
mregus@pacificalloy.com
www.pacificalloy.com

PCi Roads LLC
Saint Michael, MN
Primary Contact: David J. Graham
dgraham@pciroads.com
www.pciroads.com

Thiessen Team USA Inc.
Elko, NV
Primary Contact: James Schumacher
info@thiessenteam.com

INDIVIDUAL MEMBERS

Alve Rutgersson
TAM International (S) Pte. Ltd.
Singapore

Antwon Vaughn
Chuck's Concrete Pumping, LLC
Richmond, VA

Steve Morgan
Sunbelt Pools of GA LLC
Atlanta, GA

Tom De Neef
T De Neef Engineering
Heist-op-den-Berg, Antwerp, Belgium

STUDENT MEMBERS

Andrew Lacelle
Clinton, NY

Babak Alizadeh
Tehran, Iran

Gareth Watson
Pacific Pines, QLD, Australia

Nurhafsyah Binti Syamsuddin
Kuala Lumpur, Selangor, Malaysia

INTERESTED IN BECOMING A MEMBER OF ASA?

Read about the benefits of being a member of ASA on page 66, and find a Membership Application on page 67.

King Packaged Materials Company

King Packaged Materials Company has been producing preblended cementitious materials from its three North American production facilities since 1962. Although the range of products produced at these facilities includes sophisticated concrete repair mortars, concrete mixtures, and cementitious grouts, King is best known throughout the continent as a leading producer of prepackaged shotcrete mixtures.

King's extensive line of shotcrete mixtures can be customized to meet the demands of almost any project. Some shotcrete products have been specifically designed to perform in the frozen temperatures of the Canadian Arctic, others to perform equally as well in the heat and humidity of the Caribbean. Some King shotcrete mixtures are designed for pumpable wet-mix applications, others for use with dry-mix equipment. But no matter what the job-site conditions or equipment on hand, any of King's products can be designed to achieve the plastic and hardened properties that suit the demands of any application.

Mining and Tunneling

Twenty-five years of experience supplying shotcrete to support the most demanding ground conditions has lead to King's participation in some of North America's major mining and tunneling projects. Highly accelerated mixtures reinforced with steel or macrosynthetic fibers have been used to speed up the mining cycle for shaft and tunnel excavations from below the streets of New York City to the hard rock mines of northern Ontario. No matter where the project, contractors and engineers have benefitted from King's commitment to a quality product, backed up by one of the strongest technical support teams in the industry.

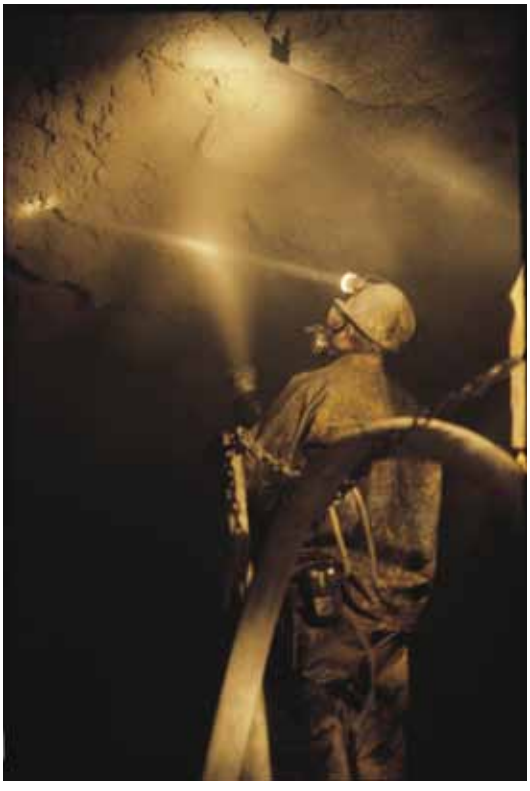
Concrete Repair and Rehabilitation

The deteriorating state of North American infrastructure has created a demand for products like shotcrete. King's research and development investment in mixture design technology has allowed them to be at the forefront when it comes

to new shotcrete technology for concrete repair. For example, King has introduced new technology designed to improve both plastic properties (improved shootability) and hardened properties (improved durability) of shotcrete. This technology has been accepted and implemented by departments of transportation and other transportation authorities from Quebec to Texas.

Although King understands the importance of a strong technical approach when producing quality shotcrete mixtures, much of the company's success can be attributed to its recognition that to design and produce a mixture that shoots well, one must first have the input and the perspective of a shotcrete nozzelman. Many of King's extensive technical support staff have been trained to ensure they have the nozzeling capabilities and skills needed to service customers. These skills can also be a benefit when testing new shotcrete mixtures before they reach the market, which gives customers confidence that the product they shoot will meet the expectations of the industry's most demanding shotcrete contractors.

For information on how you can benefit from years of experience researching, testing, and producing prepackaged shotcrete mixtures, contact King Packaged Materials Company at (800) 461-0566 or e-mail constructionproducts@kpmindustries.com.



Shotcrete Education and Demonstration at ICRI Symposium on Concrete Placement Techniques and Foundation Wall Waterproofing

On October 9, 2009, ASA Past Presidents Rusty Morgan of AMEC Earth & Environmental Limited and Larry Totten of Johnson Western Gunite Company gave keynote PowerPoint presentations at an International Concrete Repair Institute (ICRI) Symposium on "Concrete Placement Techniques and Foundation Wall Waterproofing" held at the Northern California Cement Mason's Facility in Pleasanton, CA.

Morgan provided a general introduction to the use of the shotcrete process for rehabilitation of infrastructure. He then followed up with an introduction to the American Concrete Institute (ACI) Shotcrete Nozzleman Certification program (for which ASA acts as the primary sponsoring group). Morgan concluded his presentations with a series of case history examples from his project files of Infrastructure Rehabilitation with Shotcrete.

Totten provided a brief history of the use of shotcrete as a concrete placement technique, with a particular emphasis on the development of the use of shotcrete in California. He then provided case history examples of the use of shotcrete for infrastructure rehabilitation (including seismic upgrades), new construction, and foundation wall waterproofing applications.

Fig. 1

Fig. 2

Fig. 3

Other speakers at the ICRI-sponsored symposium included Jim Markovich of Ferrari Moe LLP, who provided a general introduction to the topic of concrete placement methods. Barry Peterson of Western Construction Group spoke on infrastructure repair with concrete form-and-pour, form-and-pump, and hand placing methods. Ken Klein, PE, of Simpson Gumpertz & Heger gave an excellent presentation on "Foundation Wall Waterproofing Challenges and Options" for shotcreted foundation walls.

In the afternoon, Johnson Western Gunite Company provided a practical demonstration of shotcreting of a mock-up foundation wall with waterproofing using the wet-mix shotcrete process (refer to Fig. 1). They also demonstrated wet-mix shotcrete construction of heavily reinforced structural walls and pilasters (as in seismic retrofit) (refer to Fig. 2). They concluded with a demonstration of a simulated wet-mix shotcrete rehabilitation of an overhead soffit (refer to Fig. 3).

The demonstrations concluded with Western Construction Group showing how to rehabilitate reinforced concrete structures using the form-and-pour, form-and-pump, and hand placement repair procedures.

This "Concrete Placement Techniques and Foundation Wall Waterproofing" symposium provided an excellent opportunity to showcase the quality and efficiency of the shotcrete placement method and the current state of the art for waterproofing shotcreted foundation walls.

EFNARC Sprayed Concrete Technical Committee Launches the EFNARC Robotic Sprayed Concrete Nozzleman Certification

The European Federation for Specialist Construction Chemicals (EFNARC) has launched the EFNARC Nozzleman Certification Scheme. In the past, EFNARC has produced well-respected Industry Guidelines and has made significant contributions to European Standards and now believes that it is time to concentrate on the other key link in providing high-quality sprayed concrete—the nozzleman.

The EFNARC Nozzleman Certification Scheme offers certification to nozzlemen who have already gained the necessary experience and can demonstrate their technical knowledge and practical ability. The scheme has been developed in recognition that the construction industry requires a means of identifying expert nozzlemen.

The scheme is currently limited to wet, robotic-sprayed concrete and has been developed primarily for the European market, although it will have a wider application.

The scheme operates through national examiners who assess nozzlemen for their theoretical and practical skills at their workplace; note that it is not a training course. The first stage

of the scheme is the identification and accreditation of suitable examiners through the attendance of an EFNARC assessment course. The first two examiner assessments have been successfully completed. Nozzleman certification will follow the successful accreditation of examiners.

Allentown Shotcrete Technology, Inc.—the New Face of Putzmeister Mortar Machines

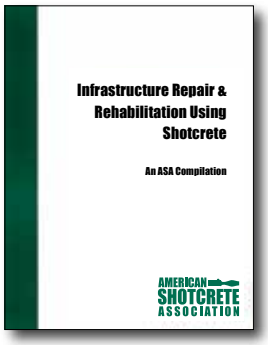
Allentown offers both Allentown and Putzmeister mortar machines for western hemisphere

Allentown Shotcrete Technology, Inc., the industry leader in the design and manufacture of wet- and dry-mix process shotcrete (also known as gunite) equipment, announces that it is offering the full line of mortar machines from both Allentown and Putzmeister for the western hemisphere.

In addition, the combination of Allentown's and Putzmeister's vast knowledge and experience in the industry, along with the combination of Allentown's distribution facility and Putzmeister Mortar Machines's (PMM) new assembly plant, allows Allentown to give back even more to their distributors.

PMM's new Aichtal, Germany, assembly plant is an impressive 96,875 ft² (9000 m²). The new plant's adoption of more optimized assembly procedures provides quicker delivery times to distributors and customers, an increase in productivity and even higher quality in each and every machine. At the PMM plant, every component is tested before it's used in manufacturing a machine as part of its comprehensive quality management. In addition, at the end of the production line, every machine is thoroughly tested in final inspection and then receives its finish, is cleaned, has standard accessories added, and is packed for shipping to the distributor or customer.

Infrastructure Repair & Rehabilitation Using Shotcrete—An ASA Compilation



The document was originally created for distribution at the last "International Bridge Conference" held in Pittsburgh, PA. Positive response to the compilation moved ASA to make the document available to the entire concrete industry.

This new compilation of papers focuses on shotcrete's use in the repair and rehabilitation of infrastructure. The 34-page black and white soft-cover book, "Infrastructure Repair & Rehabilitation Using Shotcrete," is a compilation of eight previously published papers in ASA's *Shotcrete* magazine.

Copies of the compilation are available for a special price of $9.00 U.S. Pricing includes shipping. To place an order, visit **www.shotcrete.org/RepairBulletin** or call (248) 848-3780.

Cooperation Agreement between Sandvik and Meyco

Worldwide mining machinery manufacturer Sandvik Mining and Construction and BASF's unit MEYCO have signed an agreement relating to global cooperation in the fields of tunneling and mining. The two companies have agreed to initiate joint operations for spare parts management and the service and maintenance of machines for sprayed concrete.

The new cooperation has been launched in different parts of the world, and this is a process that will continue. To date, the cooperation has been established in northern and southern Europe, as well as the U.S., Canada, and Mexico.

The global launch of the cooperation will continue in Eastern Asia, Western Asia, and Australia Pacific. Practical implementation will be conducted on a step-by-step basis. Each country will introduce the relevant service to customers according to their specialized schedule.

Putzmeister America, Inc., Forms Partnership

Special Applications Business focuses on complete systems approach

Putzmeister America, Inc.'s Special Applications Business (SAB) announces its partnership between Allentown Shotcrete Technology, Inc., Esser Pipe Technology, and Milwaukee-based Maxon Industries, Incorporated (Maxon). The result of this partnership is a complete systems approach that offers all products to all projects in the tunnel and mining, dams and power generation, transportation, and marine and offshore industries.

SAB is the combination of four separate divisions, including the concrete products division (CPD), Putzmeister underground concrete (PUC), precast applications (PCA), and large infrastructure projects (Civil).

"We revamped our overall approach with customers and their projects to maintain our high customer satisfaction and status as the global leader in concrete and material placing technology," says Bill Carbeau, Director of both SAB and Allentown. "Our complete systems approach includes constant contact with the customer from the estimating stages of a project to working with customers on delivery times, and customizing confidential solutions for unique scenarios, service, parts and training, as well as maintenance of equipment."

The SAB group specialists include:

- **Bill Carbeau** (Group Leader, Putzmeister and Allentown), long-distance and underground concreting;
- **Bill Maxon** (Maxon), systems transportation;
- **Bob Weiglein** (Telebelt® Division Manager, Telebelt and belt delivery;
- **Patrick Bridger** (Allentown's President), shotcrete and underground applications; and
- **Goran Vujasinovic** (International Telebelt Sales Manager), civil and overland systems.

Signs of Recession End and Jobs Returning in Associated Builders' 2010 Forecast

While the construction industry battled the effects of the recession in 2009, expect 2010 to be a sluggish transition on the road to recovery, says ABC Chief Economist **Anirban Basu**. "Through late 2008, the industry held up well," he added. "But 2009 was a year of retrenchment for many construction sectors, including those associated with private development and municipal projects. Overall, the nonresidential construction industry has been impacted by a combination of financing constraints, massive job loss, and a lack of confidence in local economies across the nation due to falling tax revenues."

Basu points out that one of the more positive aspects for contractors has been declining construction materials prices, which are expected to remain stable in the coming months, making it possible for contractors to submit bids on long-term projects with great confidence.

Long-Term Cement Consumption Could Spell Domestic Shortfall

Although United States' cement consumption is expected to decline to 83 million U.S. tons (75 million metric tons) in 2009, compared to near-record 2005 levels of 141 million U.S. tons (128 million metric tons), a recent PCA Economic Research 25-year forecast cites market factors that could propel domestic powder demand upwards of 212 million U.S. tons (192 million metric tons) by 2035.

One of the more startling aspects of this outlook is that consumption trends appear to spell trouble, with both short- and long-term production shortfalls expected. Climate change legislation, plant emissions regulations, and sustained high oil prices are likely to result in the elimination of wet-process cement production, which accounts for approximately 15% of all U.S. powder, and could force the closure of a significant portion of domestic mill capacity. Add to that the likely growth in cement usage even in the next 5 years (consumption levels are expected to hit 134 million U.S. tons [122 million metric tons] by 2015), the potential for a 110 million U.S. ton (100 million metric ton) domestic supply gap may materialize by 2035. Large investments, in either new import terminals or new domestic capacity, will be required to close the supply gap.

Personnel News

Putzmeister America, Inc., Appoints New Thom-Katt® National Sales Manager

Drew Williams

Putzmeister America, Inc., announces **Drew Williams** as its new Thom-Katt® National Sales Manager. Reporting directly to Bill Dwyer, Vice President, Sales & Marketing for Putzmeister America, Williams' sole responsibility will be to oversee all sales and customer relationships in regard to Thom-Katt trailer pumps for Putzmeister America. Williams will be located at Putzmeister America's corporate offices in Sturtevant, WI. "Drew has extensive industry experience that's invaluable," notes Dwyer. "I have confidence he will step into his new role with enthusiasm and determination."

Most recently, Williams held the position of Eastern Regional Sales Manager for Allentown Shotcrete Technology, Inc. (Allentown), where he was responsible for both inside and outside sales. "While at Allentown, Drew demonstrated his unwavering dedication and leadership to growing the business," says Patrick Bridger, President of Allentown. "I have no doubt he will do the same at Putzmeister."

NRMCA promotes Karthik Obla to VP Technical Services

The National Ready Mixed Concrete Association (NRMCA) has named Staff Engineer **Karthik Obla**, PhD, PE, FACI, to Vice President, Technical Services. He previously served as Managing Director, Research and Materials Engineering.

Obla has more than 18 years of experience in concrete technology and has interests in quality control, mixture optimization, specifications, use of recycled materials, and durability. He oversees NRMCA's concrete laboratory and research program, having increased the laboratory's participation in funded research through federal and other funding agencies and contract testing for NRMCA members. He has made contributions in the association's P2P initiative and focused on improving quality in ready mixed operations. He is a winner of ACI's Young Professional Achievement Award. Obla is an active member of various ACI, ASTM, and Transportation Research Board technical committees and serves as Chair for ASTM Subcommittee C09.49, Pervious Concrete, and ACI Committee 232, Fly Ash and Natural Pozzolans in Concrete. He has published over 50 technical articles in journals and has presented at several international conferences.

"We are very happy to announce this news," said NRMCA President **Robert Garbini**. "Karthik's leadership role in raising the profile of our research laboratory is a significant positive development for NRMCA. He has shown outstanding ability in this and his other responsibilities, and we look forward to his continued contributions to the association and ready mixed concrete industry as well."

Shotcrete Industry Says Goodbye to David Rudin

David Rudin, 62, of Mesa AZ, passed away on September 10, 2009, after a courageous year-long battle with pancreatic cancer. Rudin made a large impact first in the Arizona shotcrete pump market with Thompsen. He then went on to regional and national levels in his further ventures with Putzmeister, a stint at both Schwing and ConForms, and then back to Putzmeister until his death.

ASA Board of Direction Approves Changes to Bylaws

The American Shotcrete Association (ASA) Board of Direction approved changes to the association's bylaws in November 2009. The changes focus on the nomination procedure for Officers and Directors. The main reason for the change was to encourage greater participation by the ASA membership in the election process of the association's leaders

The current version of the ASA Bylaws is available at **www.shotcrete.org**.

2010 ASA Annual Membership Meeting and Awards Banquet—February 2, 2010

There is still time to register for this outstanding event. Held at the Monte Carlo Hotel in Las Vegas, NV, this event is a "must-attend" for anyone involved with the shotcrete industry. An open bar reception begins at 6:00 p.m.; dinner and the evening's events begin at 7:00 p.m. To register for this event, go to **www.shotcrete.org** or call (248) 848-3780.

2010 WOC Committee Meetings—February 1, 2010, at the Las Vegas Convention Center

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

These committee meetings offer participants the opportunity to network with colleagues, to provide input on shotcrete materials and publications, and to become an integral part of ASA's overall mission. These meetings do not require preregistration and are open and free to anyone who has an interest in the shotcrete process.

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

ASA Graduate Scholarships Awarded

For the 2009-2010 academic year, ASA has awarded Graduate Scholarships to **Benjamin Turner** and **Nicolas Ginouse**. Each student will receive a stipend of $3000 (USD) for tuition, residence, books, and materials for the 2009-2010 academic year.

Benjamin Turner

Nicolas Ginouse

Benjamin Turner received his Bachelor of Science in civil engineering from California Polytechnic State University (Cal Poly) and is currently working toward earning a Master of Science in civil engineering at the same university. While at Cal Poly, Turner has worked as an intern at AIS Construction. His work there involved the design, bidding, and construction of multiple soil nail walls, as well as tunnel projects that involved the use of shotcrete. Currently, he is working on a design for the expansion of a tunnel roof using shotcrete and rockbolts in the North American Aerospace Defense Command (NORAD)

underground command center. Turner plans to focus his career on this fascinating and growing micro-industry.

Nicolas Ginouse received his degree in mechanical and industrial engineering from Arts et Métiers Paristech in Paris, France, and he is currently pursuing an MS in civil engineering from Laval University, Quebec, QC, Canada. Ginouse is beginning his graduate studies on the shotcrete team at Laval University where the main objective of his project is to model the mixture flow at the outlet of the nozzle to predict particle velocity, speed distribution of the stream, and the effects on rebound. Ginouse is considering pursuing his studies in shotcrete at the PhD level. Afterward, he would like to use his expertise in shotcrete and mechanical engineering to help develop shotcrete equipment and processes. Ultimately, through his industrial contacts in France, he is very interested in promoting exchanges between the North American and European shotcrete industries.

Established in 2008, the purpose of the ASA Graduate Scholarship Program is to identify, attract, and assist outstanding graduate students pursuing careers within the field of concrete with a significant interest in the shotcrete process. For a complete description of these awards, requirements, and directions, visit **www.shotcrete.org**, and click on Grad Scholarships.

ASA Exhibits at the 2009 International Pool | Spa | Patio Expo

Held November 3-5, 2009, at the Mandalay Bay Convention Center in Las Vegas, this show was an excellent opportunity for ASA to reach out to this important segment of the shotcrete industry. Whereas the ASA booth fielded a wide range of questions and inquiries, the main message was that of the importance of educated and certified nozzlemen. Handouts focusing on this message were among the numerous sources of information distributed from the booth as well as a new compilation of pool-and-recreational-project-related articles from *Shotcrete* magazine. The show also featured a number of shotcrete-themed seminars and a live demonstration, both conducted by ASA members.

BASF Construction Chemicals Launches Meyco Poca Shotcrete Spraying Mobile

BASF Construction Chemicals has released the Meyco Poca shotcrete spraying mobile, which has been specifically developed for use in small- to medium-sized mining operations.

The compact, self-contained unit combines features and performance normally associated with "full-scale" machines.

The Meyco Poca is 6.4 yd (5.85 m) long, 202 yd (2 m) wide and 2.5 yd (2.24 m) high with the boom retracted and has been designed with a tight turning circle. This enables it to go where larger machines cannot, in areas such as cross-passages and access tunnels. The unit's heavy-duty Dieci chassis and large heavy-profile tires can deliver mobility and maneuverability on steep slopes and difficult ground conditions. The unit also features four-wheel drive, four-wheel crab steering, and a ROPS/FOPS cabin.

The Meyco Poca is available as either an electrically-powered spraying unit or as a fully diesel-driven unit. Both models incorporate Meyco's Simpla double-piston concrete pump, a Rama 6 manipulator, and either a 2.6 or 3.5 in. (65 or 85 mm) delivery and nozzle system.

The units have a maximum spraying height of 10 yd (9.2 m) and width of 17.5 yd (16 m) and are capable of outputting up to 28.6 yd^3 (22 m^3) of shotcrete per hour.

Fiberstrand and Tuf-Strand SF Fibers from The Euclid Chemical Company

The Euclid Chemical Company provides Fiberstrand microsynthetic fibers and Tuf-Strand SF macrosynthetic fibers for concrete reinforcement. Fiberstrand fibers come in various packaging and length configurations and protect concrete against plastic shrinkage cracking. Tuf-Strand SF can be used for precast concrete, slabs-on-ground, pavement, and shotcrete applications. It's also UL-certified for composite metal deck construction. This patented synthetic fiber can be added at high volumes to concrete without affecting finishing and placing characteristics.

Fibercon International Steel Fibers

Fibercon steel fibers are incorporated into concrete to provide temperature and shrinkage reinforcement for slabs-on-ground, composite metal decks, and shotcrete applications. These low-carbon steel fibers come in lengths of 1 to 2 in. (25 to 50 mm). The fibers are manufactured with either continuous or end deformations for improved bonding to the concrete matrix, and their unique design allows for easy batching and finishing. Fibercon's computer design program allows for easy determination of fiber dosage for all applications.

BASF Construction Chemicals MasterFiber Line

The MasterFiber™ line of microsynthetic, macrosynthetic, and steel fibers offers exceptional product performance. The fibers redistribute the stresses within concrete to restrain the mechanism of crack formation, propagation, and extension, resulting in a more ductile reinforced concrete that can maintain a residual load-carrying capacity in the post-cracking phase. MasterFiber M100, a new innovative mono-filament fiber, reduces plastic shrinkage cracking by about 85%. MasterFiber F series fibrillated fibers also reduce shrinkage and temperature cracking. BASF's proprietary Fiber Dosage Wizard helps quantify the cost savings that can be realized by using MasterFiber macrosynthetic fibers in place of other reinforcement.

RMC Foundation Releases Revised Edition of Popular LEED Guide

The RMC Research & Education Foundation has released the third edition of its popular Ready Mixed Concrete Industry LEED Reference Guide (LEED Guide). This revised edition incorporates new LEED 2009 for New Construction and Major Renovations (LEED 2009 NC) information and provides guidance on how concrete may contribute to gaining LEED points for construction projects seeking certification in the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) green building certification system. The LEED Guide was originally published in 2005.

"The USGBC continues to improve and update the LEED program so the Foundation has done the same with its LEED Guide," said RMC Research & Education Foundation Chairman Karl Watson Jr., adding, "participation in the LEED certification program has exploded over the last few years and the Foundation's LEED Guide has no doubt helped to increase awareness of the LEED program, particularly in the concrete industry."

The LEED Guide is available for download from the Foundation's Web site at www.rmc-foundation.org. It is also available as part of the Foundation's free Research Supporting Sustainable Development CD. Hard copies of the LEED Guide are available for purchase for a nominal fee from NRMCA at **www.nrmca.org**.

The mission of the RMC Research & Education Foundation is to support research and educational programs that will increase professionalism and quality in the concrete industry.

ACPA Launches Certification Promotion Program

The American Concrete Pumping Association (ACPA) has begun launching an industry-wide promotion of the ACPA Certified Operator Program, informing contractors on the benefits of using certified operators when pumping concrete. The promotion encourages contractors to choose companies whose operators are ACPA certified when selecting a pumping service for their jobs.

The ACPA Operator Certification Program is the only industry-recognized certification program that provides an independent written assessment of an operator's knowledge regarding concrete pump safety. Certification has proven to increase knowledge and the safety awareness of an operator, thereby helping to reduce workplace incidents that can lead to serious injury, loss of time, and increased insurance costs and litigation. For more information, visit **www.concretepumpers.com**.

Do you have a new product or practice that the shotcrete world should know about? Send us information at info@shotcrete.org.

Shotcrete FAQs

As a service to our readers, each issue of *Shotcrete* will include selected questions and answers received by the American Shotcrete Association (ASA). Questions can be submitted to: info@shotcrete.org. Selected FAQs can also be found on the ASA Web site, at **www.shotcrete.org/ASAfaqs.htm**.

Question: *I am a pool builder who favors dry-mix shotcrete. I have a project requiring: a) cast-in-place concrete retaining walls, where there will be exposed downhill faces (that are not necessarily meant to be seen). Should my shotcrete contractor be able to finish the exposed face in some sort of reasonable finished appearance? and b) placing a pool house foundation (about 4 ft [1.2 m] high). Would I be able to shoot these? I am thinking not because there is no place for the rebound to go.*

Answer: a) Shotcrete can be finished in a wide variety of ways. It can be left with anywhere from a very rough to a very smooth finish and a huge variety of other finishes. We suggest you visit ASA's Web site, click on the tab for *Shotcrete* magazine, and search the previous articles for finishes and swimming pools. You will find a lot of photos of great-looking walls. Not all shotcrete contractors are proficient in providing these attractive finishes. You need to discuss this with your current shotcrete contractor and/or interview other shotcrete contractors to make sure the chosen contractor can provide what you are looking for. We also suggest you look at work these contractors have previously completed. You can also locate contractors online at ASA's Buyers Guide, **www.Shotcrete.org\BuyersGuide**.

b) If the pool house foundation is a footing trenched into the ground 4 ft (1.2 m) deep, dry-mix shotcrete would not be a good solution. If the foundation is 4 ft (1.2 m) above grade, then it could be done with shotcrete against a one-sided form. This would be considered structural shotcrete and not all shotcrete contractors are qualified to place shotcrete for structural walls. Again, we suggest you ensure the chosen contractor is qualified to do the work.

Question: *Our client has a retaining wall that has experienced movement in the precast concrete panels and has asked us to research a product that could be applied to give a smooth look to the retaining wall. Is shotcrete a possible option? I would also like information on the recycled content of shotcrete.*

Answer: Shotcrete is basically concrete that is pneumatically applied. Shotcrete can be used as an overlay for an existing wall to provide structural strengthening and a smooth look. Again, we suggest that you visit ASA's Web site and search previous *Shotcrete* magazine articles for finishes. Before the shotcrete is applied, the wall must be stabilized from any anticipated future movement. Relatively thin layers of shotcrete or concrete will not withstand future wall movements without distress and cracking.

The recycled content of most shotcrete mixtures is limited to the substitution of fly ash or other pozzolans for a percentage of the cement in the mixture. To properly place shotcrete, this substitution is generally limited to approximately 25% of the cement content.

Question: *We recently stained a shotcrete wall. After we placed the staining on the wall, the stain came out in different shades across the wall, in effect bring out the different curing of the concrete. What can be done to eliminate this inconsistency?*

Answer: It is not unusual to have variations in the tone of color for shotcrete or concrete walls that have been stained due to variation of the texture or density of the surface being stained. An acid-based stain typically results in more consistent shading.

When anticipating that a wall will be stained, extra care needs to be taken in the curing process. It is generally recommended that walls to be stained should be water-cured to avoid any interaction between a curing compound and the stain material. If a curing compound is used, it must be completely removed prior to applying the stain material. Consult the stain supplier for more information.

Question: *I have a seawall with a gunite (dry-mix shotcrete) outer layer. The gunite layer has cracked in multiple locations on the seawall resulting from years of exposure to the harsh environment. The original gunite was not part of a soil nail system. I am considering a re-coat of shotcrete probably 3 to 4 in. (76 to 100 mm) thick with wire mesh and L-anchors on a 2 to 3 ft (0.6 to 0.9 m) grid. I know the importance of surface treatment for bonding, etc., but I am not sure if I should remove the original gunite layer (which is still sound in some places) or apply the re-coat. The new overlay needs to be structurally effective. I know that a soil nail system is the most dependable solution, but cost is a major concern. Do you have any suggestions?*

Answer: The new shotcrete layer can be added to the existing shotcrete or installed after the existing shotcrete is removed. The decision to remove or not remove the existing shotcrete is beyond the scope of what we can comment on.

If the existing shotcrete is left in place and overlayed, it should be thoroughly cleaned and roughened to create a good bonding surface. Because this is in a marine environment and you are considering the use of wire mesh, you need to make the new layer thick enough to have sufficient cover on the reinforcing steel. Alternately you could consider the use of fiber-reinforced shotcrete and silica-fume-enhanced fibrous shotcrete. Please note that there are many types of fibers on the market. We recommend that you review some of the *Shotcrete* magazine articles on fibrous shotcrete and on shotcrete in a marine environment on the ASA Web site. We suggested two papers for reference. The first is by Gilbride, Bremner, and Morgan on the Port of Saint John, and the other is by Morgan on the use of fibers that cover marine repairs.

You mentioned using "L-anchors" at 2 to 3 ft (0.6 to 0.9 m) spacing. The use of grouted anchors with a reasonable embedment is quite common, but the design of such anchors is again beyond the scope of what we can advise.

Shotcrete FAQs

Question: *We will be tiling a pool. The pool's shotcrete walls and floor were placed approximately 10 days ago. What is the earliest we can begin gauging the pool walls and floors?*

Answer: It is generally good practice to let the shotcrete cure for the full 28 days before attempting to apply coatings or overlays. We would recommend you get a recommendation on the cure time from the manufacturer of the gauging product before doing the work.

Question: *We are considering the use of bentonite in a blind-side waterproofing situation to waterproof a basement with shotcrete as the confinement material. The basement has a 8.2 ft (2.5 m) head of water permanently against it (approximately 6.5 ft [2 m] higher than the slab/shotcrete wall construction joint).*

In brief, we intend to construct as follows:

1. Pump the area dry;
2. Place secant piles, and then apply shotcrete over the piles. The shotcrete will be troweled to accept the bentonite;
3. Apply the bentonite sheet membrane to the troweled shotcrete;
4. Tie two rows of reinforcing steel at 11.8 ft (300 mm) centers in each direction;
5. Shoot shotcrete through the steel onto the bentonite tanking; and
6. Turn the pumps off once the curing period is complete.

We have been advised this will be effective. Any advice on this system would be greatly appreciated, as we believe using shotcrete rather than cast-in-place concrete as the confinement material would result in significant cost savings. We know little, however, of the confinement properties of shotcrete.

Answer: The use of shotcrete over waterproofing in blind-side applications is not uncommon; and, as you note, it is generally very efficient from a cost and schedule standpoint. It should be noted that the shotcrete applicator (shotcrete contractor) should be very experienced in high-quality structural shotcrete work. The application of shotcrete in tunnels, canals, channels, or swimming pools is very different from the application of shotcrete for structural walls. The experienced structural shotcrete contractor will use experienced and knowledgeable tradesmen including a certified ACI nozzleman.

There are many types of waterproofing material including sodium bentonite, as you mentioned. Other membrane material and additives can be added to the shotcrete mixture as delivered. It is not within our scope to comment on the choice of these materials. You can contact the various manufactures or engage a waterproofing professional to give you the proper advice. The ASA online Buyers Guide is a great starting point in locating qualified professionals.

ASA Sustainability Committee Holds Its First Meeting

The first meeting of the ASA Sustainability Committee took place at ASA's Fall Meetings in New Orleans, LA, last November. The meeting was a great start for this new endeavor for ASA.

A number of important first steps were completed, not the least of which was the appointment of a committee Chair. With strong support from the entire committee, **Charles Hanskat** of Concrete Engineering Group, LLC, in Northbrook, IL, was appointed the committee Chair.

With the committee infrastructure now established, the Sustainability Committee will begin work on a number of short- and long-term objectives. One of the first efforts will be to work with the U.S. Green Concrete Council (a for-profit subsidiary of the American Concrete Institute) on the development of two chapters in an important new document for the entire construction industry. The document, with a planned release in fall 2010, is titled "The Sustainable Concrete Guide–Applications" and will serve as a reference for the architect/engineer on how to best use concrete products and systems in a sustainable manner. The ASA Sustainability Committee will be working with the U.S. Green Concrete Council to create material for planned chapters on "shotcrete" and "concrete repair."

Longer-term objectives for the new Sustainability Committee will focus on identifying and quantifying the sustainability benefits of shotcrete. These benefits will be used in ASA's promotion of shotcrete and in the creation of a document listing and explaining these benefits for use by our members as they bid/compete on projects against other construction processes/materials.

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.

Concrete Sustainability Hub Launched at MIT

To address the sustainability and environmental implications of the use of concrete as the backbone of our housing, schools, hospitals, and other built infrastructure, including highways, tunnels, airports, and rail systems, Massachussetts Institute of Technology (MIT) has announced the creation of the Concrete Sustainability Hub (CSH), a research center established at MIT in collaboration with the Portland Cement Association (PCA) and Ready Mixed Concrete (RMC) Research and Education Foundation.

CSH, established with the goal of accelerating emerging breakthroughs in concrete science and engineering and transferring that science into practice, will provide $10 million of sponsored research funding during the next 5 years. Researchers from MIT's School of Engineering, School of Architecture and Planning, and Sloan School of Management are expected to participate in CSH's research activities.

EPA Targets Construction-Site Pollution

The Environmental Protection Agency (EPA) has issued a final rule aimed at reducing pollution from construction sites, saying that it will significantly improve the quality of water nationwide. The rule will be phased over 4 years, starting in February 2010.

Nearly 82,000 home builders, commercial and industrial building contractors, and civil engineering companies are expected to be covered by the rule, which the EPA estimates will impose about $953 million of annual costs.

Such costs could raise home prices and cause a small number of builders to go out of business, resulting in some job losses, the EPA said in a draft version of the final rule. It said that job losses may be temporary, given the relatively high turnover in the construction industry, and acknowledged that the new rule is being introduced at a time when construction has fallen off sharply. "However, the 4-year phasing process is expected to give the industry sufficient time to experience several years of growth before all the rule requirements are in effect," the EPA draft said.

Construction site owners and operators covered by the rule will have to use best management practices, including soil stabilization and erosion control, to ensure that soil that is

excavated, moved, or otherwise disturbed by construction activity doesn't pollute nearby bodies of water. In addition, owners and operators at larger construction sites will be subject for the first time to federal monitoring requirements and limits on storm water discharges. The monitoring requirements will take effect first at sites that disturb 20 or more acres and eventually at sites of 10 or more acres.

The EPA said the rule, which will establish minimum national standards, is intended to work in concert with existing state and local regulations that may be more stringent.

Adoption of the rule came in response to a court order in a lawsuit brought by a handful of states and nonprofit environmental groups alleging that the agency had failed to issue regulations required under the Clean Water Act. A U.S. district court ordered the EPA to issue the rule no later than December 1, 2009.

National Green Building Code is in the Works

The Sustainable Building Technology Committee is an arm of the International Code Council, a Washington association of 50,000 members that develops residential and commercial building codes and standards that states, counties, and municipalities adopt or use as a guide in creating their own.

This committee, which has been meeting since July of 2009 in various cities, is a collection of a variety of specialists, including architects; plumbers; masons; and lighting, heating, ventilation, and air-conditioning experts. Their goal is to create a code to guide all development of green commercial buildings in the U.S.

The International Green Building Code would, as its name implies, also be available to other countries. But drafting it has been the work of U.S. construction professionals who share a desire for the built environment to incorporate more green features.

Pennsylvania is one of only two states with a government representative on the 28-member drafting body. The other is California, the only state to have a Green Building Code.

The Green Building Code would address only commercial development. Last year, the International Code Council and the National Association of Home Builders developed green standards for municipalities and other governing bodies to use for residential construction.

Like most building projects, the green construction code is not expected to be without controversy when the first draft goes public in March for evaluation and input. Some of the proposals call for cutting construction waste by 50%.

The public-comment period on the first draft of the international code will run through next summer, concluding with a hearing in Chicago in August. A revised draft will be considered at hearings in spring 2011 in Dallas, with the code council slated to adopt a final version that year at its annual convention in Phoenix.

2010 Concrete Sustainability Conference

The National Ready Mixed Concrete Association (NRMCA) is partnering with the School of Sustainable Engineering and The Built Environment at Arizona State University (ASU) to co-sponsor the 2010 Concrete Sustainability Conference, scheduled for April 13-15, 2010, in Tempe, AZ. The fifth annual conference will provide learning and networking opportunities on the latest advances, technical knowledge, continuing research, tools, and solutions for sustainable concrete manufacturing and construction. Researchers, academics, students, engineers, architects, contractors, concrete producers, public works officials, material suppliers, and concrete industry professionals are invited to attend, submit papers, and give presentations. Topics include:

- Low-Impact Development;
- Urban Heat Island Reduction;
- Carbon Footprint and Embodied Energy;
- Sustainable Development Initiatives;
- Recycled Materials;
- Performance-Based Concrete;
- Government Initiatives; and
- Private Initiatives.

For more information on this conference, visit **www.concretetechnologyforum.org**.

BASF Develops Green Sense Concrete Technology for Sustainable Concrete

The Admixture Systems business of BASF Construction Chemicals announced that it has developed an advanced concrete optimization service that results in new levels of performance, profitability, and sustainability. Successfully piloted over the last 2 years with more than 100 concrete producers, Green Sense Concrete technology uses BASF's mixture proportioning expertise to determine the optimal combination of recycled materials and tailor-made chemical admixtures needed to improve the desired slump, setting characteristics, strength, and durability of concrete.

In addition, because Green Sense Concrete technology incorporates supplementary cementitious materials (SCMs) and fillers, it may contribute to earning Leadership in Energy and Environmental Design (LEED) credits in the Innovation and Design and Materials and Resources categories.

Green Sense Concrete is part of the BASF Construction Chemicals portfolio of environmentally preferable and sustainable technologies, many of which can be considered for LEED credits. For more information on Green Sense or to learn about BASF's sustainable admixture products, visit **www.basf-admixtures.com/GreenSense**.

ASA ANNOUNCES AVAILABLITY OF NEW ONLINE BUYERS GUIDE

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

The new American Shotcrete Association (ASA) Buyers Guide is now available free to the concrete industry at **www.shotcrete.org/BuyersGuide**.

The ASA Buyers Guide provides a new and 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 new 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/BuyersGuide • (248) 848-3780

2010 AMERICAN SHOTCRETE ASSOCIATION Buyers Guide

The following list of ASA Corporate Members is current as of December 1, 2009.

For a current listing, including the ability to search by seven major specialties (as well as over 100 subspecialties) and states/provinces served, visit the online ASA Buyers Guide at **www.Shotcrete.org/BuyersGuide**.

AMEC Earth & Environmental — CONSULTING
2227 Douglas Road
Burnaby, BC, V5C 5A9, Canada
Phone: (604) 294-3811
Web site: www.amec.com
E-mail: john.laxdal@amec.com
Contact: John Laxdal

Acme America, Inc. — EQUIPMENT
PO Box 269
Coopersburg, PA 18036-0269
Phone: (800) 458-2263
Web site: www.acmeamerica.com
E-mail: acme@acmeamerica.com
Contact: John Ferraris

Advanced Construction Techniques Ltd.
3935 Lloydtown Aurora Road
Kettleby, ON, L0G 1J0, Canada
Phone: (905) 939-7755
Web site: www.advancedconstructiontechniques.com
E-mail: jcockburn@agtgroup.com
Contact: James Cockburn

Advanced Shotcrete, Inc. — CONSULTING, CONTRACTORS, EQUIPMENT
PO Box 25065
Salt Lake City, UT 84125-0065
Phone: (801) 908-7664
Web site: www.advancedshotcrete.com
E-mail: therin@advancedshotcrete.com
Contact: Therin Ramos

Aircrete Systems LP Inc. — ADMIXTURES, CONSULTING, CONTRACTORS, CEMENT/POZZOLANIC MATL, EQUIPMENT, FIBERS, SHOTCRETE MATERIALS/MIXES
4 Industry Way SE
Calgary, AB, T3S 0A2, Canada
Phone: (403) 203-0492
E-mail: lamanagement@shaw.ca
Contact: Jack Radu

Airplaco Equipment Company — EQUIPMENT
4141 Airport Road
Cincinnati, OH 45226
Phone: (513) 321-4511
Web site: www.airplaco.com
E-mail: sales@airplaco.com
Contact: Todd Ferguson

Allentown Shotcrete Technology, Inc. — EQUIPMENT
421 Schantz Road
Allentown, PA 18104-9494
Phone: (610) 398-0451
Web site: www.allentownshotcrete.com
E-mail: bridgerp@allentownshotcrete.com
Contact: Patrick Bridger

Allied North America Insurance Brokerage of California, LLC — CONSULTING, CONTRACTORS
39300 Civic Center Drive, Suite 390
Fremont, CA 94538-2337
Phone: (510) 578-2000
Web site: www.alliedna.com
E-mail: mnorton@alliedna.com
Contact: Marcus A. Norton

Alltech Solutions Inc — CONTRACTORS
104 Rooney Cres
Moncton, NB, E1E 4M3, Canada
Phone: (506) 858-9432
Web site: www.alltechsolutions.ca
E-mail: tomilson@alltechsolutions.ca
Contact: Trevor Tomilson

American Concrete Restorations, Inc. — CONTRACTORS
11S375 Jeans Road
Lemont, IL 60439-8839
Phone: (630) 887-0670
Web site: www.americanconcreterestorations.com
E-mail: cathy@americanconcreterestorations.com
Contact: Cathy Burkert

Atlantic Underground Services Ltd.
425 Pine Glen Road
Riverview, NB, E1B 4J8, Canada
Phone: (506) 387-8160
E-mail: info@ausltd.com
Contact: Terry Keiver

Azteca Gunite
6626 Flinklock
Houston, TX 77040
Phone: (713) 462-5566
Web site: www.aztecagunite.com
E-mail: info@aztecagunite.com
Contact: Ozzie Martinez

B&A Contractors, Inc. — CONTRACTORS
PO Box 1306
Florence, AL 35631-1306
Phone: (888) 779-0277
Web site: www.bacontractorsinc.com
E-mail: keith@bacontractorsinc.com
Contact: Brad Holmes

BASF Admixtures Inc
23700 Chagrin Boulevard
Cleveland, OH 44122-5506
Phone: (216) 839-7015
Web site: www.basf-admixtures.com
Contact: Chris Gause

Buyers Guide, cont.

Baker Concrete Construction, Inc.
900 North Garver Road
Monroe, OH, 45050
Phone: (580) 332-7267
Web site: www.bakerconcrete.com
Contact: Robert Nussnierz

Bekaert Corporation CONSULTING, CONTRACTORS, EQUIPMENT, FIBERS
1395 S Marietta Parkway SE, Building 500, Suite 100
Marietta, GA 30067-4440
Phone: (800) 555-1775
Web site: www.bekaert.com
E-mail: Michael.Hyland@bekaert.com
Contact: Michael Hyland

BelPacific Excavating & Shoring Ltd. CONSULTING, CONTRACTORS
3183 Norland Avenue
Burnaby, BC, V5B 3A9, Canada
Phone: (604) 205-0002
Web site: www.belpacific.com
E-mail: greg@belpacific.com
Contact: Gregory Samcheck

The Blanchard Group
4586 Route 134
Allardville, NB, E8L 1E2, Canada
Web site: www.blanchardgroup.ca
E-mail: rene@blanchardgroup.ca
Contact: Rene Blanchard

Blastcrete Equipment Co. ADMIXTURES, CONSULTING, CONTRACTORS, CEMENT/POZZOLANIC MATL, EQUIPMENT, SHOTCRETE MATERIALS/MIXES
PO Box 1964
Anniston, AL 36202-1964
Phone: (256) 235-2700
Web site: www.blastcrete.com
E-mail: jim@blastcrete.com
Contact: Jim Farrell

Boral Material Technologies Inc CEMENT/POZZOLANIC MATL
200 Mansell Court E, Suite 305
Roswell, GA 30076-4852
Phone: (770) 552-3383
E-mail: kevin.foody@boral.com
Contact: Kevin Foody

Boulderscape Inc. CONTRACTORS
33081 Calle Perfecto, Suite A
San Juan Capistrano, CA 92675
Phone: (949) 661-5087
Web site: www.boulderscape.com
E-mail: steve@boulderscapeinc.com
Contact: Steve Jimenez

C-TEC, Inc. CONTRACTORS
1928 S Lincoln Avenue
York, NE 68467-9467
Phone: (402) 362-5951
Web site: www.ctecconcrete.com
E-mail: ctec@ctecconcrete.com
Contact: Greg Wurst

CWS Source, Inc. CONSULTING, CONTRACTORS, CEMENT/POZZOLANIC MATL, SHOTCRETE MATERIALS/MIXES
12600 Robin Lane, Suite 100
Brookfield, WI 53005-3124
Phone: (262) 781-4329
Web site: www.cwssource.com
E-mail: info@cwsbec.com
Contact: Guy Hanna

California Skateparks, Inc. CONSULTING, CONTRACTORS
273 N Benson Avenue
Upland, CA 91786-5676
Phone: (909) 949-1601
Web site: www.californiaskateparks.com
E-mail: info@californiaskateparks.com
Contact: Joseph M. Ciaqlia Jr.

Cemen Tech Inc. ADMIXTURES, EQUIPMENT
1700 N 14th Street
Indianola, IA 50125-1584
Phone: (515) 961-7407
Web site: www.cementech.com
E-mail: info@cementech.com
Contact: Darren Huinker

Cementec Industries, Inc. ADMIXTURES, CEMENT/POZZOLANIC MATL
288 - 200 Rivercrest Drive SE
Calgary, AB, T2L 2X5, Canada
Phone: (403) 720-6699
Web site: www.cementec.ca
E-mail: info@cementec.ca
Contact: Joseph Kiss

Coastal Gunite Construction Company CONTRACTORS
PO Box 977
Cambridge, MD 21613-0977
Phone: (410) 228-8100
Web site: www.coastalgunite.com
E-mail: coastalgunite1@aol.com
Contact: R. Curtis White Jr.

Con Arch Engineering
6930 N Camino Martin
Tucson, AZ 85741-2215
Phone: (520) 744-0722
Web site: www.con-arch.com
E-mail: info@con-arch.com

Conco Cement Companies CONTRACTORS
5141 Commercial Circle
Concord, CA 94520-8523
Phone: (925) 685-6799
Web site: www.theconcocompanies.com
E-mail: mcusack@concopumping.com
Contact: Mike Cusack

ConCreate USL Ltd CONTRACTORS, EQUIPMENT, FIBERS
135 Commercial Road
Bolton, ON, L7E 1R6, Canada
Phone: (800) 363-7580
Web site: www.usl-1983.com
E-mail: usl@usl-1983.com
Contact: Karen Brigden

Concrete Repairs & Contracting Co.
PO Box 45962
Abu Dhabi, United Arab Emirates
Phone: 01197126336128
Web site: www.repcrete.com
E-mail: repcrete@emirates.net.ae
Contact: Khaled Naddeh

Conshot Systems, Inc.
450-1550 Alberni Street
Vancouver, BC, V6G 1A5, Canada
Phone: (604) 689-4468
E-mail: rossking@telus.net
Contact: Ross King

www.Shotcrete.org/BuyersGuide

Construction Forms, Inc. EQUIPMENT
777 Maritime Drive
Port Washington, WI 53074
Phone: (800) 223-3676
Web site: www.conforms.com
E-mail: info@constructionforms.com
Contact: Alan J. Kastelic

Contech Services, Inc.
PO Box 84886
Seattle, WA 98124
Phone: (206) 763-9877
Web site: www.contechservices.com
E-mail: pete@contechserviceswa.com
Contact: Peter Barlow

Cowin & Company, Inc.
PO Box 19009
Birmingham, AL 35219-9009
Phone: (205) 945-1300
Web site: www.cowin-co.com
E-mail: jcowinsr@cowin-co.com
Contact: John J. Cowin

Craig Olden, Inc. CONSULTING, CONTRACTORS
PO Box 5000
Little Elm, TX 75068-9000
Phone: (972) 294-5000
Web site: www.oldeninc.com
E-mail: colden@oldeninc.com
Contact: Craig Olden

The Crom Corporation
250 SW 36th Terrace
Gainesville, FL 32607-2889
Phone: (828)277-2666
Web site: www.cromcorp.com
E-mail: 4lob@cromcorp.com
Contact: Lars Balck Jr.

Custom-Crete Inc.
4433 Terry O Lane
Austin, TX 78745
Phone: (512) 443-5787
Web site: www.custom-crete.com
Contact: Bill Heath

DBM Contractors, Inc. CONTRACTORS
1220 S 356th Street, Suite 1
Federal Way, WA 98003-7467
Phone: (253) 838-1402
Web site: www.dbmcontractors.com
E-mail: tarmour@dbmcm.com
Contact: Tom Armour

Dees Hennessey Inc.
200 Industrial Road, Suite 190
San Carlos, CA 94070-6233
Phone: (650) 595-8933
E-mail: deeshenn@pacbell.net
Contact: Daniel M. Evans

Deluxe Shotcrete & Concrete Construction CONSULTING, CONTRACTORS, SHOTCRETE MATERIALS/MIXES
PO Box 385
Santa Rosa, CA 95402-0385
Phone: (707) 568-1200
Web site: www.deluxeshotcrete.com
E-mail: cindy@deluxeshotcrete.com
Contact: Cindy Culley

DOMTEC International, LLC CONSULTING, CONTRACTORS
4355 N Haroldsen Dr.
Idaho Falls, ID 83401-1105
Phone: (208) 522-5520
Web site: www.domtec.com
E-mail: domtec@domtec.com
Contact: Ryan Poole

Donald J Scheffler's Construction CONTRACTORS
15815 Amar Road
City of Industry, CA 91744-2107
Phone: (626) 333-6317
E-mail: mailbox@heidicorp.com
Contact: Donald J. Scheffler

Douglas Aquatics, Inc. CONTRACTORS
1900 E Belt Boulevard
Richmond, VA 23224-6304
Phone: (804) 232-8027
Web site: www.douglasaquatics.com
E-mail: gabe.crouch@douglasaquatics.com
Contact: Thomas Gabriel Crouch

Drake Inc. CONTRACTORS
1919 Road Q
Waco, NE 68460-8826
Phone: (402) 362-1863
Web site: www.drakeinc.net
E-mail: davedrake@alltel.net
Contact: David Drake

Drakeley Industries
74 Hickory Lane
Bethlehem, CT 06751-2308
Phone: (203) 263-7919
Web site: www.drakeleypools.com
E-mail: bill@drakeleypools.com
Contact: William T. Drakeley Jr.

Drill Tech Drilling & Shoring, Inc. CONSULTING, CONTRACTORS
2200 Wymore Way
Antioch, CA 94509-8548
Phone: (925) 978-2060
Web site: www.drilltechdrilling.com
E-mail: ryan@drilltechdrilling.com
Contact: Ryan Nagle

East Coast Shotcrete CONTRACTORS
76 Ridgeway Avenue
West Orange, NJ 07052-3219
Phone: (973) 731-2147
Web site: www.eastcoastshotcrete.com
E-mail: tommy@eastcoastshotcrete.com
Contact: Tommy Pirkle

Eastern Gunite Company, Inc. CONTRACTORS, EQUIPMENT
303 Commerce Drive
Exton, PA 19341
Phone: (610) 524-5590
Web site: www.easterngunite.com
E-mail: EGunite@aol.com
Contact: Thomas F. Lyons

Elkin Hi-Tech, Inc.
2879 Oakland Avenue
Indiana, PA 15701
Phone: (724) 349-6300
Web site: www.elkinhitech.com
E-mail: elkin@elkinhitech.com
Contact: Frank Holuta

Buyers Guide, cont.

Engineering & Construction Innovations, Inc.
780 Barge Channel Road
Saint Paul, MN 55107
Phone: (651) 298-9111
Web site: www.eandci.com
E-mail: shane@eandci.com
Contact: Shane McFadden

Epoxy Design Systems, Inc.
PO Box 19485
Houston, TX 77224-9485
Phone: (713) 461-8733
Web site: www.epoxydesign.com
E-mail: jamesa@epoxydesign.com
Contact: James Applegath

The Euclid Chemical Company ADMIXTURES, CEMENT/ POZZOLANIC MATL, FIBERS
19218 Redwood Road
Cleveland, OH 44110-2799
Phone: (216) 531-9222
Web site: www.euclidchemical.com
E-mail: dmillette@euclidchemical.com
Contact: Daniel Millette

Fibercon International Inc. ADMIXTURES, CONTRACTORS, FIBERS
100 South 3rd Street
Evans City, PA 16033-9264
Phone: (724) 538-5006
Web site: www.fiberconfiber.com
E-mail: nick@fiberconfiber.com
Contact: Nicholas Mitchell Jr.

Fisher Shotcrete, Inc. CONTRACTORS
PO Box 1360
Higley, AZ 85236
Phone: (480) 897-7824
Web site: www.fishershotcrete.com
E-mail: jfisher@www.fishershotcrete.com
Contact: Janice Fisher

Forta Corporation FIBERS
100 Forta Drive
Grove City, PA 16127
Phone: (800) 245-0306
Web site: www.fortacorp.com
E-mail: info@fortacorp.com
Contact: Daniel T. Biddle

Frontier-Kemper Constructors, Inc.
1695 Allen Road
Evansville, IN 47710
Phone: (812) 426-2741
Web site: www.frontierkemper.com
E-mail: jmcmahon@frontierkemper.com
Contact: Jim McMahon

Gibbons Pools Inc.
171 Bridge Road
Islandia, NY 11749-5202
Phone: (631) 581-8258
Web site: www.gibbonspools.com
Contact: Ron Gibbons

Great Lakes Concrete Restoration, Inc. CONTRACTORS
622 East Woodruff Avenue
Toledo, OH 43604
Phone: (419) 255-8209
Web site: www.glcr.biz
E-mail: glcr@sbcglobal.net
Contact: Robert Duffy

Grindline Skateparks Inc. CONSULTING, CONTRACTORS
4619 14th Avenue SW
Seattle, WA 98106-1501
Web site: www.grindline.com
E-mail: mark@grindline.com
Contact: Roger Mark Hubbard

Group Works LLC CONSULTING, CONTRACTORS
PO Box 7269
Wilton, CT 06897
Phone: (203) 834-7905
Web site: www.groupworksllc.com
E-mail: jmscott@optonline.net
Contact: James Scott

Gunite Specialists Inc.
2939 Felton Road
Norristown, PA 19401-1359
Phone: (610) 239-0988
E-mail: gsipoolfinishes@live.com
Contact: Scott Zimmerman

Hardcore Shotcrete Skateparks Inc. CONSULTING, CONTRACTORS
601 S McKinley Avenue
Joplin, MO 64801-3220
Phone: (888) 758-2696
Web site: www.hardcoreskateparks.com
E-mail: info@hardcoreskateparks.com
Contact: Mark Leone

Hydro-Arch CONTRACTORS
980 Mary Crest Road, Suite B
Henderson, NV 89014-7875
Phone: (702) 566-1700
Web site: www.hydro-arch.com
Contact: Wolf Michelson

J Tortorella Swimming Pools Inc. ADMIXTURES, CONSULTING, CONTRACTORS, SHOTCRETE MATERIALS/MIXES
1764 County Road 39
Southampton, NY 11968-5245
Phone: (631) 283-7373
Web site: www.tortorella.com
E-mail: joey@tortorella.com
Contact: Joe Tortorella

John Rohrer Contracting Company, Inc. CONTRACTORS
2820 Roe Lane, Building S
Kansas City, KS 66103-1560
Phone: (913) 236-5005
Web site: www.johnrohrercontracting.com
E-mail: brandon@johnrohrercontracting.com
Contact: Brandon D. McMullen

Johnson Western Gunite Company CONTRACTORS
940 Doolittle Drive
San Leandro, CA 94577-1021
Phone: (510) 568-8112
Web site: www.jwgunite.net
E-mail: larryt@johnsonwesterngunite.com
Contact: Larry J. Totten

Joseph J. Albanese Inc. CONSULTING, CONTRACTORS
986 Walsh Avenue
Santa Clara, CA 95050-2649
Phone: (408) 640-6219
Web site: www.shotcrete.us
E-mail: czynda@jjalbanese.com
Contact: Chris Zynda

KHM Inc.
PO Box 2672
Binghamton, NY 13902-2672
Phone: (607) 773-0076
E-mail: khmwbe1989@aol.com
Contact: Kathleen Hall

King Packaged Materials Company EQUIPMENT, FIBERS, SHOTCRETE MATERIALS/MIXES
3385 Harvester Road
Burlington, ON, L7N 3N2, Canada
Phone: (905) 639-2993
Web site: www.kingshotcrete.com
E-mail: jhutter@kpmindustries.com
Contact: Joe Hutter

Knowles Industrial Services Corp. CONTRACTORS
295 New Portland Road
Gorham, ME 04038-1867
Phone: (207) 854-1900
Web site: www.knowlesindustrial.com
E-mail: dmaloney@knowlesindustrial.com
Contact: Dan Maloney

The Kryton Group of Companies ADMIXTURES
1645 East Kent Avenue
Vancouver, BC, V5P 2S8, Canada
Phone: (604) 324-8280
Web site: www.kryton.com
E-mail: leo@kryton.com
Contact: Leo Connell

Laborers' Training & Retraining Trust Fund for Northern CA
1001 Westside Drive
San Ramon, CA 94583
Phone: (925) 828-2513
E-mail: vmacias@norcalaborers.org
Contact: Vic Macias

Lafarge North America CONSULTING, CEMENT/POZZOLANIC MATL
30600 Telegraph Road, Suite 4000
Bingham Farms, MI 48025-4530
Phone: (248) 594-1991
Web site: www.lafargenorthamerica.com
E-mail: ken.kazanis@lafarge-na.com
Contact: Ken Kazanis

Mar-Allen Concrete Products Inc CONTRACTORS
490 Millway Road
Ephrata, PA 17522-9528
Phone: (717) 859-4921
E-mail: jlzimmerman@marallen.com
Contact: Jeffrey L. Zimmerman

Mays Construction Specialties Inc. CONTRACTORS
2399 Riverside Parkway
Grand Junction, CO 81505-1324
Phone: (970) 254-8957
Web site: www.mays-mcsi.com
E-mail: kvanderberg@mays-mcsi.com
Contact: Kyle R. Vanderberg

Meadow Valley Contractors, Inc. CONSULTING, CONTRACTORS, EQUIPMENT
4602 E Thomas Road
Phoenix, AZ 85018-7710
Phone: (602) 325-1196
Web site: www.meadowvalley.com
E-mail: hrobbins@meadowvalley.com
Contact: Howard Robbins

Metro Testing Laboratories Ltd.
6991 Curragh Avenue
Burnaby, BC, V5J 4V6, Canada
Phone: (604) 436-9111
Web site: www.metrotesting.ca
E-mail: nmcaskill@metrotesting.ca
Contact: Neil McAskill

Mid American Gunite Pools, Inc. CONTRACTORS
1607 Eastern Avenue
Covington, KY 41014-1325
Phone: (859) 581-8566
Web site: www.midamericanpools.com
E-mail: pool1boss@fuse.net
Contact: Patrick M Brennan

Modern Concrete, Inc.
PO Box 5711
Elko, NV 89802-5711
Phone: (775) 753-5100
Web site: www.modernconcrete.net
E-mail: kelley@modernconcrete.net
Contact: Kelley Sweeden

The Nassal Company CONSULTING, CONTRACTORS
415 W Kaley Street
Orlando, FL 32806-3942
Phone: (407) 648-0400
Web site: www.nassal.com
E-mail: info@nassal.com
Contact: Matt Brown

Nationwide Shotcrete Inc. CONTRACTORS
23404 Lyons Avenue, Suite 273
Newhall, CA 91321
Phone: (661) 799-3750
E-mail: nationwideshotcrete@yahoo.com
Contact: Jordan Harpole

North County Gunite Co Ltd.
12562 Highway 67
Lakeside, CA 92040-1159
Phone: (619) 561-5510
Web site: www.northcountygunite.com
E-mail: tom@northcountygunite.com
Contact: Thomas E. Wares

Northern Sierra Corporation
5450 East Road
Saginaw, MI 48601-9748
Phone: (989) 777-4784
Contact: Ross Lake

Oldcastle APG West, Inc. CEMENT/POZZOLANIC MATL
4150 W Turney Avenue
Phoenix, AZ 85019-3327
Phone: (602) 390-3240
Web site: www.superliteblock.com
E-mail: dave.endres@oldcastleapg.com
Contact: Dave Endres

Osco Gunite & Mudjacking Ltd. CONTRACTORS
5920 98 Street
Edmonton, AB, T6E 3L5, Canada
Phone: (780) 469-1234
Web site: www.shotcreting.com
E-mail: osco@mudjacking.com
Contact: Larry Hnatiuk

Buyers Guide, cont.

PciRoads LLC CONTRACTORS, EQUIPMENT
14123 42nd Street NE
Saint Michael, MN 55376-9563
Phone: (763) 497-6100
Web site: www.pciroads.com
E-mail: dgraham@pciroads.com
Contact: David J. Graham

PJ's Concrete Pumping Service Inc. ADMIXTURES, CONTRACTORS, EQUIPMENT, FIBERS
22366 Pepper Road
Barrington, IL 60010
Phone: (847) 381-3105
Web site: www.pjsconcrete.com
E-mail: pj@pjsconcrete.com
Contact: Pierre Lareau

Pacific Alloy Casting Company, Inc. EQUIPMENT
5900 Firestone Boulevard
South Gate, CA 90280
Phone: (562) 928-1387
Web site: www.pacificalloy.com
E-mail: mregus@pacificalloy.com
Contact: Mark Regus

Palmetto Gunite Construction Co., Inc. CONTRACTORS
PO Box 388
Ravenel, SC 29470
Phone: (843) 889-2227
Web site: www.palmettogunite.com
E-mail: thendpalgun@cs.com
Contact: Thomas A. Hendricks

Pool Engineering Inc. CONSULTING, CONTRACTORS
1201 N Tustin Avenue
Anaheim, CA 92807-1646
Phone: (714) 630-6100
E-mail: RonL@pooleng.com
Contact: Ron Lacher

Preferred Pool Construction Services, Inc. CONSULTING, CONTRACTORS, FIBERS
12351 S Maple Grove Road
Kuna, ID 83634-2690
Phone: (208) 562-0189
Web site: www.preferredpoolconstructionservices.com
Contact: Scott G. Smith

Prestige Concrete Products
8529 S Park Circle, Suite 320
Orlando, FL 32819-9064
Phone: (561) 478-9980
E-mail: pampey@msn.com

Pristine Pools & Spas ADMIXTURES, CONSULTING, CONTRACTORS, CEMENT/POZZOLANIC MATL, FIBERS, SHOTCRETE MATERIALS MIXES
9490 W Fairview Avenue
Boise, ID 83704-8101
Phone: (208) 321-0212
Web site: www.pristinepoolandspa.com
E-mail: tj@pristinepoolandspa.com
Contact: T.J. Brown

ProShot Concrete, Inc. CONTRACTORS
4158 Musgrove Drive
Florence, AL 35630
Phone: (256) 764-5941
Web site: www.proshotconcrete.com
E-mail: patm@proshotconcrete.com
Contact: Patrick A. Mooney

Putzmeister America, Inc. EQUIPMENT
1733 90th Street
Sturtevant, WI 53177
Phone: (262) 886-3200
Web site: www.putzmeister.com
E-mail: pmr@putzam.com
Contact: Kelly Hayes

The Quikrete Companies CEMENT/POZZOLANIC MATL, SHOTCRETE MATERIALS/MIXES
3490 Piedmont Road, Suite 1300
Atlanta, GA 30305
Phone: (724) 539-6600
Web site: www.quikrete.com
E-mail: dbittner@quikrete.com
Contact: Dennis Bittner

RCS Consulting & Construction Company Inc.
PO Box 714
Ripley, WV 25271-0714
Phone: (304) 372-5574
E-mail: kschallom@rcscoinc.com
Contact: Kathleen Schallom

REED Shotcrete Equipment CONSULTING, CONTRACTORS, EQUIPMENT, SHOTCRETE MATERIALS/MIXES
13822 Oaks Avenue
Chino, CA 91710-7008
Phone: (909) 287-2100
Web site: www.reedpumps.com
E-mail: mike.newcomb@reedmfg.com
Contact: Mike Newcomb

RG Johnson Company, Inc.
25 South Collage Street
Washington, PA 15301
Phone: (724) 222-6810
Web site: www.rgjohnsoninc.com
E-mail: rich@rgjohnsoninc.com
Contact: Richard E. Adasiak

Rahm Industrial Services, Inc. CONTRACTORS
1881 84th Street SE
Caledonia, MI 49316-7944
Phone: (616) 656-0900
E-mail: rahmindustrial@aol.com
Contact: Bradley D. Rahm

Ram Jack of Charlotte, LLC
PO Box 2991
Huntersville, NC 28070-2991
Phone: (704) 892-2900
Web site: www.ramjackcharlotte.com
E-mail: markramjack@bellsouth.net
Contact: Mark Beckham

Restek, Inc. CONTRACTORS
6601 Boucher Drive
Edmond, OK 73034
Phone: (405) 330-3950
E-mail: restek@flash.net
Contact: Ellery N. Brown

Robert H Ward & Associates CONSULTING, CONTRACTORS
3300 Holeman Avenue
Chicago Heights, IL 60411
Phone: (708) 756-0767
Web site: www.rhwardandassociates.com
E-mail: shotcreterjr@hotmail.com
Contact: Blake Rago

www.Shotcrete.org/BuyersGuide

Rock & Company
995 N 5th Avenue
Brighton, CO, 80603-5123
Phone: (303) 637-9230
Web site: www.rockandco.com
E-mail: Bruce@rockandco.com
Contact: Bruce Davis

Schnabel Foundation Company
2950 S Jamaica Court, Suite 107
Aurora, CO 80014-2686
Phone: (303) 696-7268
Web site: www.schnabel.com
E-mail: todd@schnabel.com
Contact: Todd Duncan

Serafina Industries Ltd. — ADMIXTURES, CONSULTING, CONTRACTORS, CEMENT/POZZOLANIC MATL, EQUIPMENT, SHOTCRETE MATERIALS/MIXES
1764 Country Road 39
Southhampton, NY 11968
Phone: (631) 259-2760
Web site: www.serafinaconcrete.com
E-mail: info@serafinaconcrete.com
Contact: Joseph Tortorella

Shotcrete Plus Montana — ADMIXTURES, CONTRACTORS, CEMENT/POZZOLANIC MATL, EQUIPMENT, FIBERS
PO Box 685
Absarokee, MT 59001-0685
Phone: (406) 328-7344
Web site: www.shotcreteplusmt.com
E-mail: shotcreteplusmt@nemont.net
Contact: Larry Mooney

Shotcrete Technologies, Inc. — ADMIXTURES, CONSULTING, CONTRACTORS, CEMENT/POZZOLANIC MATL
PO Box 3274
Idaho Springs, CO 80452-3274
Phone: (303) 567-4871
Web site: www.shotcretetechnologies.com
E-mail: info@shotcretetechnologies.com
Contact: Kristian Loevlie

Shotcrete Unlimited Inc. — CONTRACTORS
136 Dunedin Drive
Bethlehem, GA 30620
Phone: (770) 307-4155
Web site: www.shotcreteunlimited.com
E-mail: bkwhitson@comcast.net
Contact: Wil Whitson

Sofis Company Inc. — CONTRACTORS
554 Bocktown Cork Road
Clinton, PA, 15026-1142
Phone: (724) 378-2670
Web site: www.sofiscompany.com
E-mail: tsofis@sofiscompany.com
Contact: Ted W. Sofis

South Shore Gunite Pool & Spa Inc.
7 Progress Avenue
Chelmsford, MA 01824
Phone: (800) 649-8080
Web site: www.southshoregunitepools.com
E-mail: rguarino@southshoregunitepools.com
Contact: Robert E. Guarino

Southwest V-Ditch, Inc.
3625 Placentia Lane
Riverside, CA 92501-1119
Phone: (951) 781-4303
Web site: www.swvditch.com
E-mail: mail@swvditch.com
Contact: Marty L. Leitzman

Spec Mix, Inc. — ADMIXTURES, CEMENT/POZZOLANIC MATL, EQUIPMENT
2025 Centre Pointe Boulevard, Suite 260
Mendota Heights, MN 55120-1267
Phone: (888) 773-2649
Web site: www.specmix.com
E-mail: info@specmix.com
Contact: Brian Carney

Stone Valley Construction, Inc. — CONSULTING, CONTRACTORS, CEMENT/POZZOLANIC MATL, EQUIPMENT, FIBERS, SHOTCRETE MATERIALS/MIXES
132 Coaldale Road
Philipsburg, PA 16866
Phone: (814) 342-7151
Web site: www.stone-valley.com
E-mail: kknepp@stone-valley.com
Contact: Ken Knepp

StrataCrete Pty Ltd.
80 Worthing Road Victoria Point
Brisbane, QLD, 4165, Australia
Phone: 61-73-2060892
Web site: www.stratacrete.com
E-mail: alby@stratacrete.com.au
Contact: Alby Loncaric

Structural Shotcrete Systems, Inc. — CONTRACTORS
12645 Clark Street
Santa Fe Springs, CA 90670-3951
Phone: (562) 941-9916
Web site: www.structuralshotcrete.com
E-mail: jason1@structuralshotcrete.com
Contact: Jason Weinstein

Sunwest Gunite Co. — ADMIXTURES, CONSULTING, CONTRACTORS, FIBERS
7045 Luella Anne NE
Albuquerque, NM 87109
Phone: (505) 821-2549
Web site: www.sunwestguniteco.com
E-mail: info@sunwestguniteco.com
Contact: Gary O'Canna

TBH & Associates, LLC
5211 NE 88th Street
Vancouver, WA 98665-0931
Phone: (360) 546-1600
Web site: www.tbhdrill.com
Contact: Peter Tapio

Testing, Engineering & Consulting Services — CONSULTING, CONTRACTORS
235 Buford Drive
Lawrenceville, GA, 30046-4945
Phone: (770) 995-8000
Web site: www.tecservices.com
E-mail: tmccants@tecservices.com
Contact: James Glenn McCants III

Texaloy Foundry Co., Inc. — EQUIPMENT
PO Box 89
Floresville, TX 78114-0089
Phone: (800) 367-6518
Web site: www.texaloy.com
E-mail: jrice@texaloy.com
Conctact: Jack Rice

Thiessen Team USA Inc. — ADMIXTURES, CONSULTING, CONTRACTORS, CEMENT/POZZOLANIC MATL, EQUIPMENT, FIBERS, SHOTCRETE MATERIALS/MIXES
1840 Sharp Access Road
Elko, NV 89801-4075
Phone: (866) 777-1205
E-mail: info@thiessenteam.com
Contact: James Schumacher

www.Shotcrete.org/BuyersGuide

Buyers Guide, cont.

Top Gun of Virginia, Inc. — CONTRACTORS
10017 Richmond Highway
Lorton, VA, 22079
Phone: (703) 550-9207
Web site: www.topgungunite.com
E-mail: info@topgungunite.com
Contact: George Benko

Topcor Services Inc. — ADMIXTURES, CONSULTING, CONTRACTORS, CEMENT/POZZOLANIC MATL, EQUIPMENT, FIBERS
12025 Industriplex Boulevard
Baton Rouge, LA 70809-5131
Phone: (225) 753-7067
Web site: www.topcor.com
E-mail: jbaker@topcor.com
Contact: James M. Baker

Truesdell Corporation
1310 W 23rd Street
Tempe, AZ 85282-1837
Phone: (602) 437-1711
Web site: www.truesdellcorp.com
Contact: Kurt Clink

Tyam Group
27474 Gloucester Way
Idergrove, BC, V4W 3Z4, Canada
Phone: (604) 533-8088
Web site: www.tyam.com
E-mail: kenjessamine@tyam.com
Contact: Ken Jessamine

Vale Inco Ltd.
18 Rink Street
Copper Cliff, ON, P0M 1N0, Canada
Phone: (705) 682-5299
Web site: www.inco.com
E-mail: mike.yao@valeinco.com
Contact: Mike Yao

W L H Construction Company — CONTRACTORS
2000 W 60th Avenue
Denver, CO 80221-6631
Phone: (303) 347-8655
Web site: www.wlhconstruction.com
E-mail: wharrison@wlhconstruction.com
Contact: Warren Harrison

Western Shotcrete Equipment Inc. — EQUIPMENT
HC 1 Box 193
Fairdealing, MO 63939-9708
Phone: (573) 857-2085
Web site: www.wseshotcrete.com
E-mail: josephharpole@wseshotcrete.com
Contact: Joe Harpole

White's Shotcrete Inc.
3750 McCullers Road
Loganville, GA 30052
Web site: www.whitesshotcrete.com
E-mail: RWhite3448@aol.com
Contact: Robert White

Wildcat Concrete Services Inc. — CONTRACTORS
PO Box 750075
Topeka, KS 66675
Phone: (785) 233-1400
E-mail: stuartj@wildcatconcrete.com
Contact: Stuart R. Johnson

Wurster Engineering & Construction
34 Carrie Drive
Greenville, SC 29615-5611
Phone: (964) 627-7751
Contact: Daryl Wurster

www.Shotcrete.org/BuyersGuide

SPECIALTIES

The following list of ASA Corporate Members is current as of December 1, 2009.
For a current listing, including the ability to search by seven major specialties (as well as over 100 subspecialties) and states/provinces served, visit the online ASA Buyers Guide at **www.Shotcrete.org/BuyersGuide**.

Admixtures

Aircrete Systems LP Inc.	Calgary, AB, Canada
Blastcrete Equipment Co.	Anniston, AL
Cemen Tech Inc.	Indianola, IA
Cementec Industries, Inc.	Calgary, AB, Canada
The Euclid Chemical Company	Cleveland, OH
Fibercon International Inc.	Evans City, PA
J Tortorella Swimming Pools Inc.	Southampton, NY
The Kryton Group of Companies	Vancouver, BC, Canada
PJ s Concrete Pumping Service Inc.	Barrington, IL
Pristine Pools & Spas	Boise, ID
Serafina Industries, Ltd.	South Hampton, NY
Shotcrete Plus Montana	Absarokee, MT
Shotcrete Technologies, Inc.	Idaho Springs, CO
Spec Mix, Inc.	Mendota Heights, MN
Sunwest Gunite Co.	Albuquerque, NM
Thiessen Team USA Inc.	Elko, NV
Topcor Services Inc.	Baton Rouge, LA

Cement/Pozzolanic Matl

Aircrete Systems LP Inc.	Calgary, AB, Canada
Blastcrete Equipment Co.	Anniston, AL
Boral Material Technologies Inc.	Roswell, GA
Cementec Industries, Inc.	Calgary, AB, Canada
CWS Source, Inc.	Brookfield, WI
The Euclid Chemical Company	Cleveland, OH
Lafarge North America	Bingham Farms, MI
Oldcastle APG West, Inc.	Phoenix, AZ
Pristine Pools & Spas	Boise, ID
The Quikrete Companies	Atlanta, GA
Serafina Industries, Ltd.	Southampton, NY
Shotcrete Plus Montana	Absarokee, MT
Shotcrete Technologies, Inc.	Idaho Springs, CO
Spec Mix, Inc.	Mendota Heights, MN
Stone Valley Construction, Inc.	Philipsburg, PA
Thiessen Team USA Inc.	Elko, NV
Topcor Services Inc.	Baton Rouge, LA

Consulting

Advanced Shotcrete, Inc.	Salt Lake City, UT
Aircrete Systems LP Inc.	Calgary, AB, Canada
Allied North America Insurance Brokerage of California, LLC	Fremont, CA
AMEC Earth & Environmental	Burnaby, BC, Canada
Bekaert Corporation	Marietta, GA
BelPacific Excavating & Shoring Ltd.	Burnaby, BC, Canada
Blastcrete Equipment Co.	Anniston, AL
California Skateparks, Inc.	Upland, CA
Craig Olden, Inc.	Little Elm, TX
CWS Source, Inc.	Brookfield, WI
Deluxe Shotcrete & Concrete Construction	Santa Rosa, CA
DOMTEC International, LLC	Idaho Falls, ID
Drill Tech Drilling & Shoring, Inc.	Antioch, CA
Grindline Skateparks Inc.	Seattle, WA
Group Works LLC	Wilton, CT
Hardcore Shotcrete Skateparks Inc.	Joplin, MO
J Tortorella Swimming Pools Inc.	Southampton, NY
Joseph J. Albanese Inc.	Santa Clara, CA
Lafarge North America	Bingham Farms, MI
Meadow Valley Contractors, Inc.	Phoenix, AZ
The Nassal Company	Orlando, FL
Pool Engineering Inc.	Anaheim, CA
Preferred Pool Construction Services, Inc.	Kuna, ID
Pristine Pools & Spas	Boise, ID
REED Shotcrete Equipment	Chino, CA
Robert H Ward & Associates	Chicago Heights, IL
Serafina Industries, Ltd.	Southampton, NY

Consulting, continued

Shotcrete Technologies, Inc.	Idaho Springs, CO
Stone Valley Construction, Inc.	Philipsburg, PA
Sunwest Gunite Co.	Albuquerque, NM
Testing, Engineering & Consulting Services	Lawrenceville, GA
Thiessen Team USA Inc.	Elko, NV
Topcor Services Inc.	Baton Rouge, LA

Contractors

Advanced Shotcrete, Inc.	Salt Lake City, UT
Aircrete Systems LP Inc.	Calgary, AB, Canada
Allied North America Insurance Brokerage of California, LLC	Fremont, CA
Alltech Solutions Inc.	Moncton, NB, Canada
American Concrete Restorations, Inc.	Lemont, IL
B&A Contractors Inc.	Florence, AL
Bekaert Corporation	Marietta, GA
BelPacific Excavating & Shoring Ltd.	Burnaby, BC, Canada
Blastcrete Equipment Co.	Anniston, AL
Boulderscape Inc	San Juan Capistrano, CA
California Skateparks, Inc.	Upland, CA
Coastal Gunite Construction Company	Cambridge, MD
Conco Cement Companies	Concord, CA
ConCreate USL Ltd	Bolton, ON, Canada
Craig Olden, Inc.	Little Elm, TX
C-TEC, Inc.	York, NE
CWS Source, Inc.	Brookfield, WI
DBM Contractors, Inc.	Federal Way, WA
Deluxe Shotcrete & Concrete Construction	Santa Rosa, CA
Donald J Scheffler's Construction	City of Industry, CA
Douglas Aquatics, Inc.	Richmond, VA
Drake Inc.	Waco, NE
Drill Tech Drilling & Shoring, Inc.	Antioch, CA
East Coast Shotcrete	West Orange, NJ
Eastern Gunite Company, Inc.	Exton, PA
Fibercon International Inc.	Evans City, PA
Fisher Shotcrete, Inc.	Higley, AZ
Great Lakes Concrete Restoration, Inc.	Toledo, OH
Grindline Skateparks Inc.	Seattle, WA
Hardcore Shotcrete Skateparks Inc.	Joplin, MO
Hydro-Arch	Henderson, NV
J Tortorella Swimming Pools Inc.	Southampton, NY
John Rohrer Contracting Company, Inc.	Kansas City, KS
Johnson Western Gunite Company	San Leandro, CA
Joseph J. Albanese Inc.	Santa Clara, CA
Knowles Industrial Services Corp.	Gorham, ME
Mar-Allen Concrete Products Inc	Ephrata, PA
Mays Construction Specialties Inc.	Grand Junction, CO
Meadow Valley Contractors, Inc.	Phoenix, AZ
Mid American Gunite Pools, Inc.	Covington, KY
The Nassal Company	Orlando, FL
Nationwide Shotcrete Inc.	Newhall, CA
Osco Gunite & Mudjacking Ltd.	Edmonton, AB, Canada
Palmetto Gunite Construction Co., Inc.	Ravenel, SC
PciRoads LLC	Saint Michael, MN
PJ's Concrete Pumping Service Inc.	Barrington, IL
Pool Engineering Inc.	Anaheim, CA
Preferred Pool Construction Services, Inc.	Kuna, ID
Pristine Pools & Spas	Boise, ID
ProShot Concrete, Inc.	Florence, AL
Rahm Industrial Services, Inc.	Caledonia, MI
REED Shotcrete Equipment	Chino, CA
Restek, Inc.	Edmond, OK
Robert H Ward & Associates	Chicago Heights, IL
Serafina Industries, Ltd.	Southampton, NY
Shotcrete Plus Montana	Absarokee, MT
Shotcrete Technologies, Inc.	Idaho Springs, CO

SPECIALTIES

The following list of ASA Corporate Members is current as of December 1, 2009.
For a current listing, including the ability to search by seven major specialties (as well as over 100 subspecialties) and states/provinces served, visit the online ASA Buyers Guide at **www.Shotcrete.org/BuyersGuide**.

Contractors, continued

Shotcrete Unlimited, Inc.	Bethlehem, GA
Sofis Company Inc.	Clinton, PA
Stone Valley Construction, Inc.	Philipsburg, PA
Structural Shotcrete Systems, Inc.	Santa Fe Springs, CA
Sunwest Gunite Co.	Albuquerque, NM
Testing, Engineering & Consulting Services	Lawrenceville, GA
Thiessen Team USA Inc.	Elko, NV
Top Gun of Virginia, Inc.	Lorton, VA
Topcor Services Inc.	Baton Rouge, LA
Wildcat Concrete Services Inc.	Topeka, KS
WLH Construction Company	Denver, CO

Equipment

Acme America, Inc.	Coopersburg, PA
Advanced Shotcrete, Inc.	Salt Lake City, UT
Aircrete Systems LP Inc.	Calgary, AB, Canada
Airplaco Equipment Company	Cincinnati, OH
Allentown Shotcrete Technology, Inc.	Allentown, PA
Bekaert Corporation	Marietta, GA
Blastcrete Equipment Co.	Anniston, AL
Cemen Tech Inc.	Indianola, IA
ConCreate USL Ltd	Bolton, ON Canada
Construction Forms, Inc.	Port Washington, WI
Eastern Gunite Company, Inc.	Exton, PA
King Packaged Materials Company	Burlington, ON, Canada
Meadow Valley Contractors, Inc.	Phoenix, AZ
Pacific Alloy Casting Company Inc.	South Gate, CA
PciRoads LLC	Saint Michael, MN
PJ's Concrete Pumping Service, Inc.	Barrington, IL
Putzmeister America, Inc.	Sturtevant, WI
REED Shotcrete Equipment	Chino, CA
Serafina Industries, Ltd.	South Hampton, NY
Shotcrete Plus Montana	Absarokee, MT
Spec Mix, Inc.	Mendota Heights, MN
Stone Valley Construction, Inc.	Philipsburg, PA
Texaloy Foundry Co., Inc.	Floresville, TX
Thiessen Team USA Inc.	Elko, NV
Topcor Services Inc.	Baton Rouge, LA
Western Shotcrete Equipment, Inc.	Fairdealing, MO

Fibers

Aircrete Systems LP Inc.	Calgary, AB, Canada
Bekaert Corporation	Marietta, GA
ConCreate USL Ltd	Bolton, ON, Canada
The Euclid Chemical Company	Cleveland, OH
Fibercon International Inc.	Evans City, PA
Forta Corporation	Grove City, PA
King Packaged Materials Company	Burlington, ON, Canada
PJ's Concrete Pumping Service Inc.	Barrington, IL
Preferred Pool Construction Services, Inc.	Kuna, ID
Pristine Pools & Spas	Boise, ID
Shotcrete Plus Montana	Absarokee, MT
Stone Valley Construction, Inc.	Philipsburg, PA
Sunwest Gunite Co.	Albuquerque, NM
Thiessen Team USA Inc.	Elko, NV
Topcor Services Inc.	Baton Rouge, LA

Shotcrete Materials/Mixes

Aircrete Systems LP Inc.	Calgary, AB, Canada
Blastcrete Equipment Co.	Anniston, AL
CWS Source, Inc.	Brookfield, WI
Deluxe Shotcrete & Concrete Construction	Santa Rosa, CA
J Tortorella Swimming Pools Inc.	Southampton, NY
King Packaged Materials Company	Burlington, ON, Canada
Pristine Pools & Spas	Boise, ID
The Quikrete Companies	Atlanta, GA
REED Shotcrete Equipment	Chino, CA
Serafina Industries Ltd.	South Hampton, NY
Stone Valley Construction, Inc.	Philipsburg, PA
Thiessen Team USA Inc.	Elko, NV
Woody Douglas Gunite Co.	Claremont, CA

Does the SHOTCRETE WORLD need to know about YOUR COMPANY and its PRODUCTS or SERVICES?

If the answer is ☑ "YES" then read on.

Advertising in *Shotcrete* magazine is the most cost-effective way to reach the shotcrete industry.

Each issue of *Shotcrete* magazine reaches a growing number of **over 10,000 readers** that includes current and potential designers, specifiers, and purchasers of shotcrete across 95 countries.

The many benefits of advertising in *Shotcrete* have significantly increased with the addition of the electronic version of the magazine.

All advertisers in *Shotcrete* will now have their advertisement appear in *BOTH* the printed copy and the new electronic copy of the magazine at no additional charge.

The electronic copy of *Shotcrete* is sent to all subscribers, and advertisements include a hot link to the advertiser's Web site.

You can also hire our design department to create professional advertising design for your company. From concept to production and printing, we can produce the promotional materials for your ad campaign.

Your advertisement in *Shotcrete* will reach the companies and people that you need to grow your business. The cost for advertising is very affordable, and will certainly provide you with the most "bang" for your advertising dollars.

Shotcrete MAGAZINE
A quarterly publication of the American Shotcrete Association

To obtain a media kit, arrange for advertising, or for answers to questions, contact: info@shotcrete.org or visit our Web site at www.shotcrete.org

AMERICAN SHOTCRETE ASSOCIATION

ASA Membership Benefits

	Corporate	Corporate - *Additional Individual*	Individual	Employees of Public Authorities or Agencies	Nozzleman	Student
Annual Dues	$750	$100	$250	$50	$50	Free
Subscription to quarterly *Shotcrete* magazine (Hard Copy)	X	X	X	X	X	
Electronic Subscription to quarterly *Shotcrete* magazine	X	X	X	X	X	X
Company & specialty information listed in ASA's online Buyers Guide	X					
Company & specialty information listed in *Shotcrete* magazine's annual Buyers Guide	X					
Links to shotcrete related government projects open for bid (*sent twice a month in the member edition of the ASA e-newletter*)	X	X	X	X	X	X
Discount on ACI Nozzleman Certification program	X					
Free advance general admittance registration to World of Concrete	X	X	X	X	X	X
Complimentary ASA shotcrete brochure each year	25		1	1		
Complimentary ASA reflective hardhat sticker each year	10		1	1		
Permission to include ASA logo on corporate letterhead and business cards	X	X	X	X		
Permission to display ASA logo on company web site	X					
Discounted Member pricing on advertising in *Shotcrete* magazine	X	X	X	X		
Free logo and link advertising on ASA website homepage for duration of each issue you advertise in Shotcrete	X					
Opportunity to submit items for Industry News and New Products & Practice sections of *Shotcrete* magazine at no charge	X	X	X	X		
Voting privileges at meetings and director/officer elections	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 become a shotcrete educator	X	X	X	X	X	
All company employees have opportunity to receive discounted Corporate Additional ASA Memberships ($150 off regular membership price for each employee)	X					
Opportunity to submit entries into the annual Outstanding Shotcrete Project Awards Program	X					
Discount on ASA Underground Shotcrete Education Program	X					
ASA Promotion of nozzleman certification on a national basis in conjunction with ACI					X	
Education & promotion of your shotcrete industry to the overall concrete industry	**X**	**X**	**X**	**X**	**X**	**X**

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 Member Company	$100
❑ Employees of Public Authorities and Agencies	$50
❑ Nozzleman	$50
❑ 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
❑ Rock Bolts

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

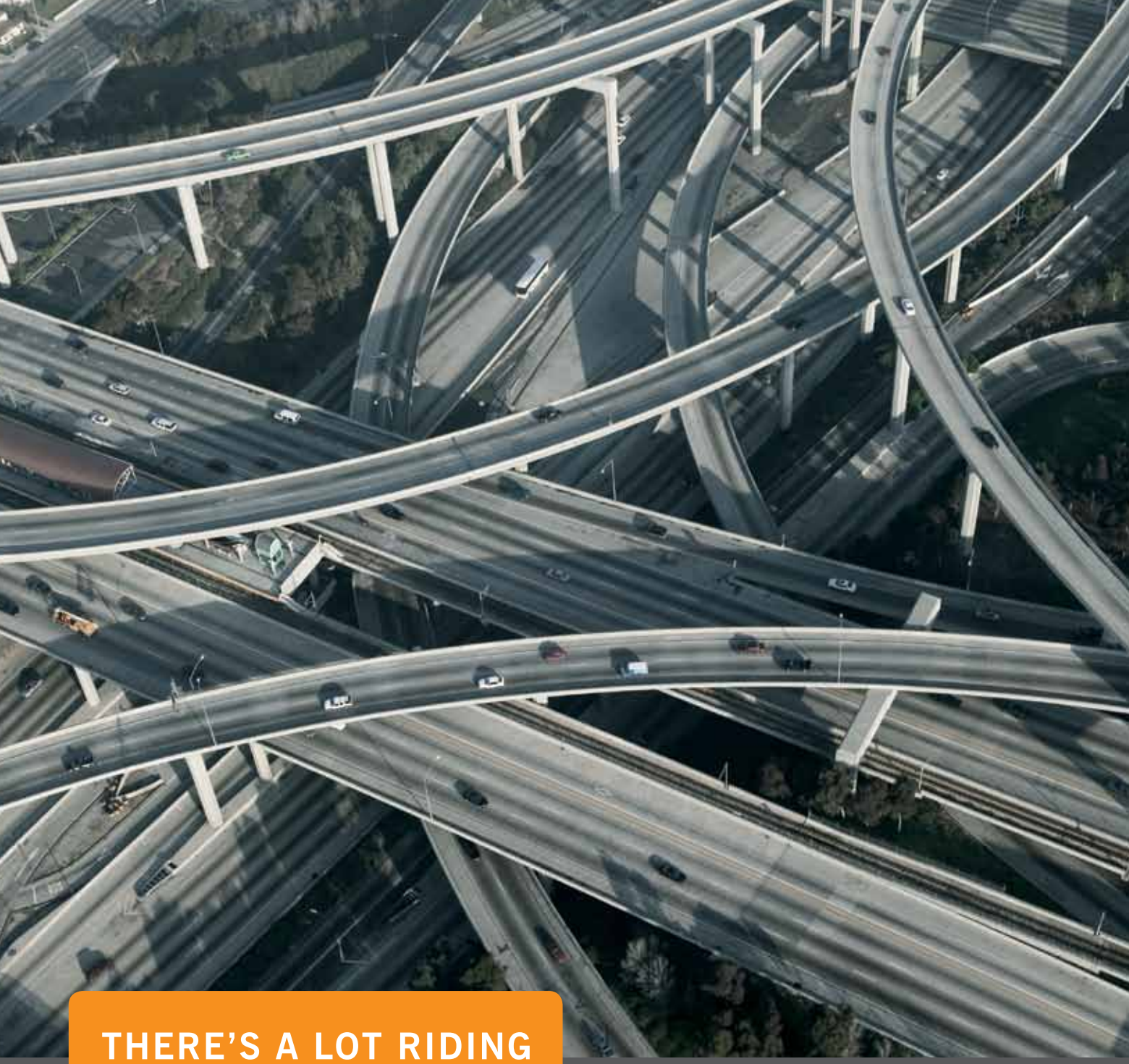
Equipment
❑ Accessories
❑ Adaptors
❑ Air Vibrators
❑ Bowls
❑ Clamps
❑ Compressors
❑ Couplings
❑ Feeder/Dosing
❑ Finishing
❑ Grouting
❑ Guide Wires
❑ Gunning Machines

Equipment, contd.
❑ 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

ADVERTISERS IN THIS ISSUE



THERE'S A LOT RIDING ON YOUR PROJECT

LET KING SUPPORT YOU

In any project, even the smallest decisions can have big consequences. Every day, our team of industry experts shares vital insights and expertise with customers like you. From Minneapolis to Manhattan and throughout the Americas, King shotcrete products come packaged with unparalleled customer support.

www.kingshotcrete.com

KING PACKAGED MATERIALS COMPANY

1 800 461-0566

www.kpmindustries.com

constructionproducts@kpmindustries.com

KING

Mixing Strength With Satisfaction

POWERCRETER® 20

Does much more than look good on paper.

MAX VOLUME OUTPUT: 17 yd^3/hr (13m^3/hr)
MAX CONCRETE PRESSURE: 2085 psi (144 bar)
MAX AGGREGATE SIZE: 1" (25mm)
HORIZONTAL PUMPING DISTANCE: 700' (210m)
VERTICAL PUMPING DISTANCE: 400' (120m)

ENGINEERED TO REDUCE PULSATION AND NOZZLEMAN FATIGUE WHEN SHOTCRETING, THE VERSATILE POWERCRETER 20 CAN BE FED BY A READY MIX TRUCK, ON-SITE MIXER, OPTIONAL INTEGRATED BATCH MIXER OR CONTINUOUS MIXER. ITS HIGH PRESSURE SWING TUBE PUMP DESIGN HANDLES HARSH MIXES, INCLUDING LOW-CEMENT, LOW MOISTURE, REFRACTORY PUMPING CASTABLES. IDEAL FOR A BROAD RANGE OF PUMPING APPLICATIONS, THE POWERCRETER 20 TURNS PERFORMANCE INTO PROFIT.

WWW.ALLENTOWNSHOTCRETE.COM/PC20 OR 1-800-553-3414

Allentown
SHOTCRETE TECHNOLOGY
A Putzmeister COMPANY

Circle #11 on reader response form—page 68