shotcrete
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MAGAZINE
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Watershapes

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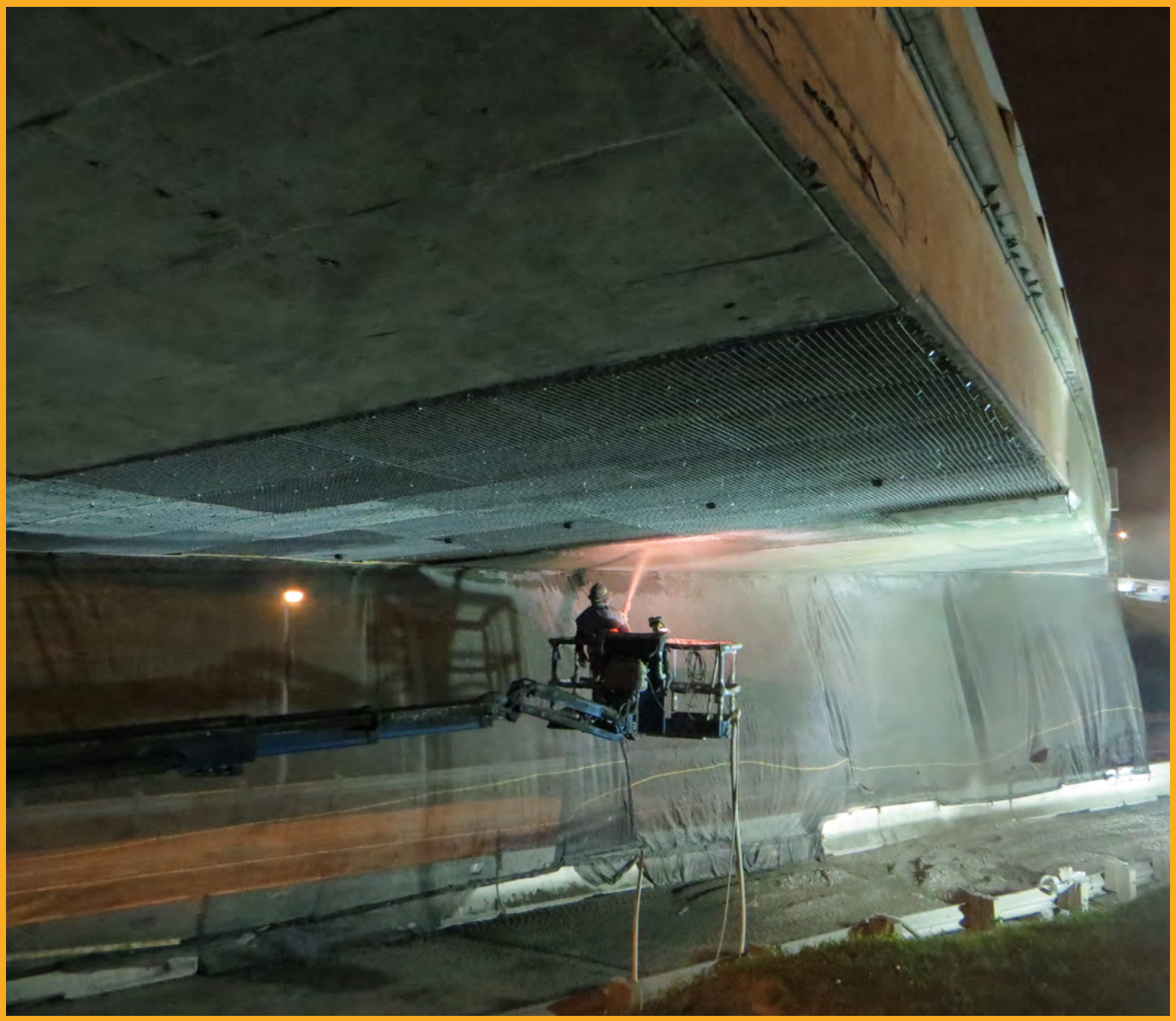

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FEATURES

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

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Editor's Note: Shotcrete is a placement method for concrete. However, for the sake of readability, the word "shotcrete" is often used either to identify the shotcrete process (method of placement) or the shotcrete mixture (product materials).

DEPARTMENTS

2020 Project Awards Honorable Mention Award Winner -
The Sherwood Residence, Greenwich, CT, USA - Drakeley Pool Company

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Workmanship

By Lars Balck

The first American Concrete Institute (ACI) Committee addressing shotcrete was ACI 805-51 "Recommended Practice for the Application of Mortar by Pneumatic Pressure" prepared by ACI Committee 805, which included three members. A more diverse shotcrete committee made up of engineers and contractors, renumbered as ACI 506, was formed in 1960. The committee soon produced two documents: 506-66 "Recommended Practice for Placement of Shotcrete" and "SP-14" a compilation of shotcrete papers. The "Recommended Practice" became the "Guide to Shotcrete" over the years and was intended to "guide" engineers and contractors.

Tom Reading, chairman of the first ACI 506 committee and, at the time, the Chief Materials Engineer for the US Army Corps of Engineers, wrote an article in the SP-14 publication about shotcrete. He detailed the results of a user survey the committee conducted and found that ***poor workmanship*** was the number one cause for user concern. Inadequate supervision and unqualified craftsmen were the principal causes of poor workmanship.

That is still true today.

As recently as last year, ASA president Cathy Burkert in her president's message wrote about her experience with an owner who refused to allow shotcrete in lieu of more expensive "form-and-pour" concrete repair because the owner was, so "upset and displeased by the poor shotcrete placement from an unqualified contractor that they decided to outlaw shotcrete indefinitely on all their jobs." Many of you, as Cathy points out, have probably had the same experience with potential clients.

Both ACI and ASA continually strive to improve the image of shotcrete. Since 1960, ACI has produced six standards, guides, tech notes and two certification programs to improve shotcrete. ASA also works to improve shotcrete's image, acceptance, and quality.

ASA has developed several programs to support companies and improve shotcrete projects:

1) ASA is the international Sponsoring Group for the ACI Certification of Shotcrete Nozzlemen, providing additional nozzleman education. Since ASA started tracking certification sessions in 2011, we have conducted over 700 sessions. Currently there are over 1800 ACI-certified nozzlemen globally. Just because a nozzleman becomes certified doesn't guarantee a perfect job. The nozzleman needs the support of an experienced crew; proper, well-maintained equipment; and quality materials. All these aspects of shotcrete placement are controlled by the contractor.
2) ASA has developed a program to Qualify Contractors. Contractors that pass the ASA review give specifiers a level of confidence that the contractor can do a good job. Though the program is relatively new it is ramping up with seven contractors designated as ASA Qualified Contractors. The application process is quite rigorous, but we

do have many contractors investing the time to complete their applications.

3) Knowledgeable shotcrete inspectors are also needed. ASA saw a distinct need to provide comprehensive shotcrete education to inspectors who may be knowledgeable about concrete but not know the details required for quality shotcrete placement. ASA members also worked with ACI to develop the ACI Shotcrete Inspector certification. To date, 22 inspectors have become "ACI-Certified Shotcrete Inspectors."
4) Shotcrete safety is a concern for our shotcrete crews. Recognizing the need to delineate safety considerations for aspects of shotcrete work, ASA produced and maintains a "Safety Guidelines for Shotcrete." This document is intended to help shotcrete contractors develop site-specific safety plans, as well as a guide for project managers and crew members.

In addition to the above programs, ASA has given many on-site and on-line seminars including our "Introduction to Shotcrete" and "Shotcrete for Underground Applications," as well as a variety of other shotcrete presentations. In the last three years we have presented to well over 3000 engineers, students, designers and owners.

ASA also annually conducts an Outstanding Shotcrete Project Awards program. The ASA Awards Program recognizes excellence and innovation in projects where shotcrete placement played a significant role. Our awards program strives to recognize and celebrate all the various markets where shotcrete placement has proven to be a practical, creative, and cost-effective method for constructing or repairing with strong, durable concrete. Winners of the 2021 Outstanding Shotcrete Project Awards will be recognized and celebrated in person during our annual Convention in Hilton Head, SC (February 27 – March 1, 2022). Registration for this much anticipated gathering will be open this October, 2021.

Poor workmanship hurts us all. ACI and ASA alone can't change owner's perception when a job goes bad, but we as a community must do better by providing proper equipment, quality materials and encouragement to our shotcrete craftsmen. Placing quality shotcrete is difficult and dirty but ultimately rewarding. As an example, look at the past winners of ASA's Outstanding Shotcrete Project Awards Program. These projects confirm and exemplify the exceptional advantages of shotcrete placement of concrete.

Cathy was right, it will take time, but by practicing quality shotcrete placement, day in and day out, we can bring users back to the reality that, "Shotcrete is equal to and in many ways superior to form-and-pour concrete."

"Basic" VS "Advanced"

By Marcus von der Hofen, Chair

As we move forward with the Contractor Qualification (CQ) Program the question of whether a Contractor is in the "Advanced" or "Basic" level of qualification has become a point of discussion with applicants and reviewers alike. Today I'll present a few of the pros and cons of this issue and attempt to shed some light on possible directions in the future.

- The policy states the "Basic" or "Advanced" level of qualification is based on **past project complexity**. Our qualification program is based upon the ASA Board of Direction Position Statement #1, "Shotcrete Contractor and Crew Qualifications."
- Four main components (not two or one) are used to determine the level to which a contractor has operated. The projects completed, field personnel involved, management involved, and the capacity of operations (which includes equipment, financial, and industry involvement) are all evaluated to reach the Basic or Advanced level designation.

"Complexity," as reviewed in this program, is more than just the complexity of performing the shotcrete alone. It also takes into consideration environmental factors, field conditions, scope of work, and all the defining attributes of the projects. The contractor's detailed explanation of how their projects meet the items from the bulleted lists below is how a contractor helps to define and establish an advanced level of expertise for the reviewers. The review groups assigned by the CQ Committee use the completed project descriptions to determine the complexity, not only of the specific project, but also the operational capabilities of the contractor to perform on a project. The project reviews also include variety. A contractor can be very skilled in one narrow type of application but that may not be enough, to be qualified as an Advanced Shotcrete Contractor. Variety is an element that sets the Advanced contractor apart with the experience, staffing, equipment, flexibility, and operational prowess to successfully execute more than one type of shotcrete project.

ASPECTS OF PROJECTS FOR CONSIDERATION AS A BASIC LEVEL OF QUALIFICATION

- Sections 6 in. (150 mm) or less in thickness
- One curtain of reinforcing with #5 (#16M) or smaller bars and non-contact lap splices with 2.5 in. (64 mm) separation
- Vertical height up to 8 ft (2.4 m)
- No overhead work
- No problems with subgrade soils or ground water
- Volume of shotcrete: 30 yd^3 (23 m^3) or less

ASPECTS OF PROJECTS FOR CONSIDERATION AS AN ADVANCED LEVEL OF QUALIFICATION

- Sections greater than 6 in. thickness
- Projects with reinforcing bars greater than #5 bars in a complex geometry or congested layout
- Vertical height over 8 ft
- Projects with overhead shooting
- Difficult access or environmental conditions
- Structures that require pre-construction test panels per the applicable Building Code
- Sections that require water stops, large embeds, pipes or movement joints

- Projects that require scaffolding, man-lifts or use of safety harnesses
- Sections that require two curtains of reinforcing or contact lap splices
- Pumping distance greater than 200 ft (60 m) horizontally or 25 ft (7.6 m) vertically
- Other aspects of advanced shotcrete construction your company has successfully completed

The CQ committee is charged with executing a comprehensive evaluation of the applicants that not only evaluates the complexity of specific projects, but also other contributing factors to a successful project, such as their overall operations, company longevity, and the ability to successfully tackle a variety of applications. The need for this comprehensive picture of what the company has done and potentially can do in the future is why the application requires a great effort on the part of the applicants. To completely document the details of their accomplishments and operations provides the reviewers with the opportunity to thoroughly evaluate the application. This also gives reviewers a basis to ask appropriate questions when verifying, via interviews, the success of each completed project with their project references. A goal of the CQ Program is to help project owners or specifiers, who are less familiar with the intricacies of quality shotcrete placement, evaluate the qualifications of the contractors bidding on their projects.

Level Designations - When developing the CQ Program, there was a recognition that each market segment had their nuances and distinctions. There was a clear desire to not make the program overly complicated with a large number of market specific levels or categories. Thus, the distinction between two levels of work, Basic and Advanced, was borne to cover the variance between project complexity.

What's basic about anything we do in the shotcrete world? The word might imply that the work completed by the contractor was simple, easy, or of less difficultly, but that may not necessarily be the case. In fact, if you're a shotcrete contractor, you find out very quickly that there is nothing easy about our trade. The term "Basic" wasn't meant to imply that a contractor is not capable of a complex shotcrete job, but it seems to have taken on that public perception. If you are a large contractor, does that make you Advanced? Correspondingly, the implication would be that if you're a small contractor… you're not. If you fairly evaluate the program, I believe you will see that is not true. Basic does not mean small nor quality deficient. A Basic level of qualification does set you apart from the new shop without a proven track record of successful projects, and without the experience to tackle difficult situations when they arise. Basic confirms that you have a proven track record for successful projects, satisfied owners and consistent quality of shotcrete placement. Unfortunately, the term "basic" might carry a perception that was more negative than we intended when establishing the CQ Program.

However, we do realize the program must grow and accept feedback from the industry. Our Pool and Recreational Shotcrete Committee has requested we consider creating a qualified shotcrete pool contractor category. The pool industry may well be the largest market for shotcrete in North America, and maybe the world. The range of shotcrete contractor abilities in this increasingly complex market is staggering. Also, due to a lack of design standards in residential pools, this is an area where the public would greatly benefit from the "pre" qualification of shotcrete pool contractors, confirming a proven track record for operations and quality. Funny thing though, when this was brought up among pool contractors, the first thing mentioned was the need for the levels "Basic" and "Advanced." Proven quality of shotcrete placement is required for both levels, and we recognize that nearly every shotcrete project is challenging. A wide variety of factors influence the success of a project. Crews, equipment, material selection and supply, scheduling, owner contact, varying specification requirements, site constraints and weather are just some of the various aspects that can make or break the success of a project. Though a company may do quality work on more limited shotcrete projects, they may not have the resources and experience to successfully complete more complex or challenging projects.

To be recognized as a Qualified Shotcrete Contractor acknowledges that you have a proven history as a company, and a track record of quality work. "Basic" should not be considered the "training wheels" of the shotcrete industry. It is not a "second place" finish. Qualified Contractors at the Basic level are highly successful and competent in their work. Pursuing projects with the complexity and variation of work we look for in the Advanced level may not be the type of work all contractors are interested in.

All ASA Qualified Shotcrete Contractors have attained the level of work quality and consistency that merits recognition and confidence. Remember, one of the primary goals of the CQ program is to help those less familiar with shotcrete recognize Qualified Contractors who have proven to their peers that they can competently and consistently provide high quality, durable shotcrete placement. And with that knowledge, feel comfortable using shotcrete on their projects.

I think we can all agree that an ASA Qualified Shotcrete Contractor at either level should be free of negative connotations. One of our committee duties is to make sure the CQ Program achieves its goal as a useful and credible tool for owners and specifiers who are considering shotcrete for their projects. The CQ Committee has carefully considered the feedback about the terms used for our level designations and recently recommended changes to the ASA Board. The recommended changes included updating the titles of the two levels to Level 1 and Level 2. This is similar to some of the ACI certifications (such as Field Testing Technician 1 and 2) and may force specifiers to review what is included in the scope of each level's projects. The Board approved the changes to the policy and the title change will be implemented for all current and future qualifications.

We never intended the CQ program to be a static policy. It must stay relevant and useful in the shotcrete construction world, while appropriately recognizing the shotcrete contractors who do a good job. This is as important for shotcrete contractors as it is for the shotcrete industry!

ASA Sustaining Corporate Members

Thank you, Sustaining Corporate Members, for your investment in the industry! ASA Sustaining Corporate Members show true dedication to ASA's vision to see "structures built or repaired with the shotcrete process accepted as equal or superior to cast concrete." These industry leaders are recognized for their exemplary level of support for the Association in a variety of ways.

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Why ASA?

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

I often get asked, "Why should I consider being a member of ASA?" With that, I reflect on why I became involved with ASA and perhaps sharing my perspective will strike a familiar note with you. My shotcrete experience started in the design-build world of wrapped prestressed concrete tanks in 1977. There I learned about shotcrete - from field placement (shooting dry-mix in the field), the design aspects needed for quality structural shotcrete, and evaluation of quality shotcrete for existing structures for extended serviceability.

Though I had been very active in ACI technical and Board committees since the early 80's, I had not been involved with ACI 506 or ACI's certification efforts until September 2006, when I joined ACI 506 as a voting member. Participation on ACI 506 was an eyeopener. Here was a technical committee that had active participation from not just engineers and educators, but many (maybe even a majority) shotcrete contractors, as well as equipment and material suppliers. Everyone in this group was dedicated to moving the acceptance of shotcrete forward. We all intuitively knew the potential shotcrete placement gave concrete construction but recognized that ACI technical documents were the key to acceptance by the design community. With the level of commitment and enthusiasm on the committee, it was easy to jump into the ACI 506 activities with both feet.

But it was also obvious that the large majority of 506 active members were also very active with ASA. So, a couple of questions formed in my mind, like why are these folks active in both ACI and ASA and how did an international trade association like ASA help advance the industry? At the time, ASA held their committee meetings immediately before and in the same hotel as the ACI meetings. This made it easy to arrive a day early to the ACI Convention and sit in on the ASA meetings to see what the heck the Association was up to.

Another eye opener! Though ASA was only eight years old at the time, it had a well-organized core group of volunteers and an efficient administrative staff to effectively get the word out about shotcrete. All the members saw the challenge was to reach the owners, designers, and builders using concrete. The goals were clearly to promote shotcrete knowledge, improve shotcrete quality, and enhance the credibility of ASA in moving shotcrete ahead in acceptance in the industry.

The tight focus and drive of the ASA members and staff generated big results including:

- Producing a high-quality, globally distributed, free quarterly magazine showcasing shotcrete, with most of the content drawn from ASA members active in building with shotcrete
- Being the primary sponsoring group for the ACI shotcrete nozzleman certification program that was instrumental in raising the quality of nozzlemen
- Developing an in-person seminar series to introduce specifiers to the quality and benefits of shotcrete
- Regular committee and Board meetings to continue the development of the Association
- Keeping ASA members intricately involved in ACI-related shotcrete and certification committees to ensure true representation in ACI documents and certifications for the advancement of both quality and acceptance of shotcrete placement in concrete construction

Knowing the inherent benefits of shotcrete and seeing the potential to grow the acceptance as an Association rather than just as an individual is what convinced me I needed to be a member, and an active member. My investment in annual membership dues were a small price to pay to belong to a collective, whose members were enthusiastic and committed to moving shotcrete forward.

That was 15 years ago and since then, I've participated in ASA in many ways: Committee member, magazine author, committee chair, elected director and officer and now as Executive Director. It is rewarding to recognize that my involvement with the Association has in some small way moved us forward in so many ways.

Today, as compared to when I joined 15 years ago, we've built on the foundation. We have:

- Expanded our outreach and education programs
- Substantially increased our credibility with specifiers
- Developed an educational program to teach inspectors about shotcrete
- Conducted an annual outstanding shotcrete project awards program
- Held shotcrete conventions and technical conferences to bring members together
- Developed a qualified shotcrete contractor program to recognize shotcrete contractor qualifications
- Produced position statements to establish acceptable practice in application areas including pools and underground

- Worked directly with many other standard developing organizations to add or improve shotcrete requirements in codes, standards, specifications, guides and manuals.

BUT WHY SHOULD YOU JOIN US AT ASA?

There are financial reasons: reduced fees for certification sessions; member pricing on bookstore items; reduced registration fees for conventions; member pricing for advertisements in Shotcrete magazine; listing in the free online Buyers Guide (sustaining & corporate members only) and press release announcements in Shotcrete magazine (sustaining & corporate members only).

Then there are the networking opportunities such as joining a committee and participating in our online communities. Voting committee membership and access to the communities is open to all individual and corporate members. Our committees produce positions statements. They develop and maintain new programs for ASA and the industry. They give guidance for increasing and improving membership and marketing efforts in the industry. Join us at our Shotcrete Convention and Technical Conference in Hilton Head, SC in late February 2022 to see for yourselves! Networking with others in the industry on a committee or at the convention is a great way to learn from their experiences. It may also give you more insight into running your business and develop long lasting friendships.

Finally, and perhaps most importantly, there is the opportunity to know you've contributed to improving shotcrete quality, safety, acceptance, and credibility in concrete construction. Maybe you don't have the time for committees or conventions, but by supporting ASA with your membership you in turn contribute to our advances. No one person can do this alone, but we as an Association, representing the best of the shotcrete industry are a strong, united voice in raising the visibility and acceptance by owners, designers, and builders to confirm our ASA vision, which is, "Structures built or repaired with the shotcrete process are accepted as equal or superior to cast concrete."

If you are not yet a member, feel free to contact me with any questions you may have at Charles.Hanskat@Shotcrete.org or 248-983-1701. If you are a member, I offer my sincere thanks for supporting ASA and the shotcrete industry. Though we've made great advances as an Association and as an industry in the last 23 years, we still have much more to achieve. Your support and the support of your fellow members is essential to continue making ASA the driving force in advancing shotcrete.

Transparent Ingenuity

Working in the custom swimming pool market requires a keen understanding of how shotcrete can be adapted to complex and challenging structures. The work necessitates creativity on one hand and adherence to ACI and ASA standards and practices on the other. It means being inventive and disciplined at the same time.

By William T. Drakeley

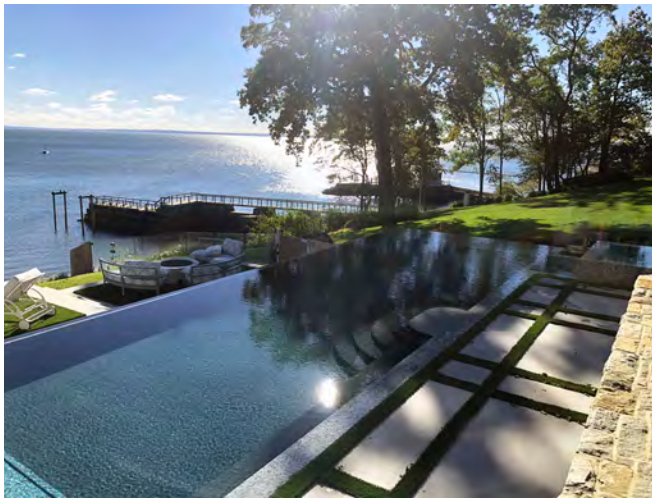
The Sherwood water shape project is something special. It's one of the more creative and challenging residential swimming pool environments we've ever created and I've been humbled by the recognition it's received.

Looking back, I now see it as a prime example of the importance of understanding how all the phases of pool building fit together and support each other. There is a healthy list of takeaways from this challenging and award-winning project. Topping that list stands the importance of understanding shotcrete and the techniques used to place it.

IN SITU

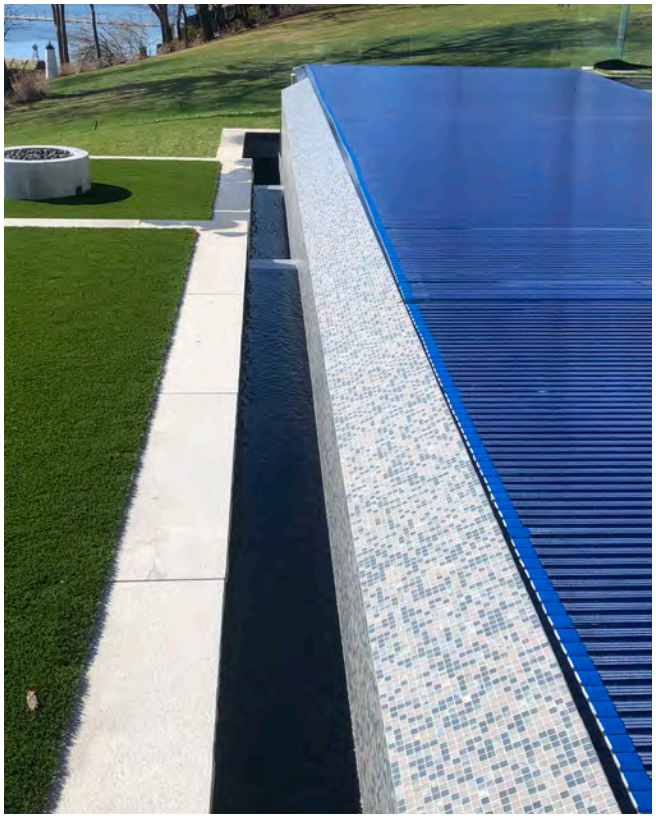
Located on the Connecticut coast overlooking Long Island Sound, the water feature drew its contemporary design from the architecture of the new house, a modern version of the old coastal mansions once built and adorned by the Rockefellers, Morgans, and Vanderbilts.

The house and surrounding architecture and landscape architecture incorporate a contemporary yet strict linear version of hillside old-world construction. It's a spectacular property that warranted an equally eye-catching water shape design.



The house and all its features, including the pool, blend into the modernist property overlooking the ocean. The pool is a reflection of the architecture and the spectacular setting. It's a three-tiered pool, spa, vanishing edge, slot overflow and acrylic panel design with a German Grando cover that rolls out from an automatic shotcrete floor vault and sits onto a shotcrete ledge along both long walls of the pool.

All of this is set on a dramatic slope – there's a 20-ft (6.1 m) drop from the top of the pool area to the bottom of the equipment vault. The soil conditions vary wildly on the property due to the site's many uses dating back to colonial days, meaning the structural design relied heavily on soils analysis and geotechnical engineering.



To effectively execute a project of this complexity, every step in the process is aimed at setting the stage for the next, from the excavation up to the finish materials. The topography and spacing of construction required marrying proven shotcrete methodology into and on top of, a form-and-pour filter vault and supporting lower wall foundation.

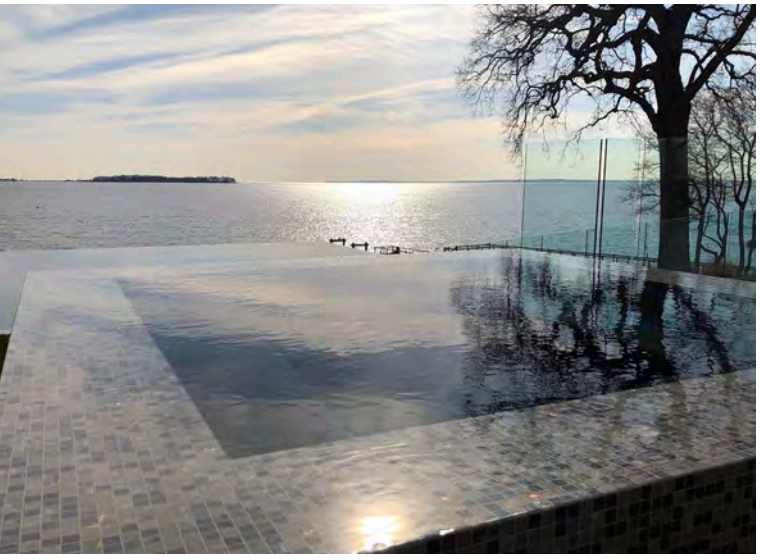
The structure's footprint and position were first established with rock and ledge removal down to a workable and competent substrate. We then cast the supporting foundational walls, footings, and locking mechanisms into the steep vertical slope of the pool area.

A BIG SHOOT

With the new concrete members and the structural foundation in place, we installed additional connecting reinforcing bars that penetrated up and into our shotcreted pool structures.

The next phase was forming and steel reinforcement installation. Unlike the cast concrete substructure, our forms were one-sided, rough-sawed lumber and plywood.

The entire pool installation was above ground, requiring some notably intricate forming. The steel reinforcement was



Grade 60, #4 (#13M) and #5 (#16M) bars, spaced at 6 in. (150 mm) to 12 in. (300 mm) with double or triple layers. All reinforcing steel was securely installed for rigidity, and free of oil and contaminants that can affect performance. In all, we installed 23 tons (21 metric tons) of reinforcing steel.

The shotcrete process took five days. The first three were for the bulk of the main pool shooting and some of the thicker wall-to-floor areas. The last couple of days were focused on the detail and close tolerances of the vanishing edge and all of the spillway lower pools.

The trickiest or most difficult part of the shotcrete placement came with the installation of the pool cover vault and the "rebate," which is the shotcrete locking mechanism or channel for the acrylic panels. Each panel, 7 ft (2 m) high and 7.5 in. (190 mm) thick, was to be recessed 1 ft (0.3 m) down into the rebate channel. The width of the rebate could be no more than 9 in. (230 mm) and must be

Shotcrete Phase

The shotcrete segment of this project was one week's worth of shotcrete placement into the pre-existing formed and reinforced sections for three interconnecting water-in-transit pools. Although it took five days to complete, there are no cold joints, and all interconnecting pools are monolithic and watertight.

There was no expansion or contraction joint, or bonding agent used between concrete connections. There are expansion materials between the acrylic and the shotcreted rebate. All next-day shooting and connecting joints were prepped to a saturated surface-dry (SSD) condition with a roughen bond plane.

We used a total of 210 yd^3 (161 m^3) of concrete.

Mixture Design

Cement (ASTM C150 Type I/II) – 750 lbs (340 kg)
Fly Ash (ASTM C618 Class C) – 50 lbs (23 kg)
Sand (ASTM C-33) – 2020 lbs (920 kg)
ASTM No. 8 (3/8 in.) – 600 lbs (270 kg)
Water – 358 lbs (162 kg)
Air Mix 250 – 1.0-2.0 oz (30 – 60 ml)
Water Reducer – 2.0 oz
Entrained Air Content – 8%-10%
Slump – 1-3 in. (25 – 75 mm)
w/c Ratio – 0.44

Equipment Used: Schwing BP500 Wet Mix Shotcrete Pump, Ingersoll Rand #375 CFM Air Compressor

Economies of Shotcrete

Benefits on this project include:

- Approximately 50% labor and material savings over conventional form-and-pour formwork
- Our formwork did not need to be designed for internal liquid concrete pressures, and thus only needed one-sided forming.
- The speed of labor increased by almost 50% because of the reduced need for overall forms in relationship to reinforcement.
- The restricted work area and its elevated accessibility could not have been completed economically or timely by any other means than the shotcrete process.
- The cost savings with materials and manpower is evident when compared to the cost of the formed foundation on this same job.

Materials Palette

The project included the installation of a variety of beautiful finish materials:

- Native stone veneer (chosen to match the home's foundational color scheme)
- Italian glass time by Bisazza
- Bluestone treads and caps from Pennsylvania Select
- Fiberglass safety grating
- Stainless (Grade 316) steel slot perimeter overflow earth supports
- Exposed aggregate plaster finish

level and square. Shooting this in an elevated condition above a shotcrete vanishing edge trough that's another 8 ft (2.4 m) deep is no day at the beach (more on the panel installation below).

The cover vault was the first shotcreted application of the pool. It sits under the pool floor and acts as a foundation for the rest of the pool with a tolerance requirement of ½ in (13 mm). For the cover lid to operate, we had to take precautions in the form of a prep or leveling coat of cementitious materials, which needed to be added to the roughened bond plane after we shot the vault. As I said, it was tricky and the tolerances in the detail work were critical.

After the concrete placement with wet-mix shotcrete, the concrete was water cured to ensure not only strength gain but also give reduced permeability and enhanced

water-tightness. Compressive values after a 28-day wet cure were between 6,000 and 7,500 psi (41 MPa and 52 MPa). For more shotcrete details, see the sidebars.

THE BIG FIT

The marquee achievement on this project was the way we married two water-retaining materials. Specifically, the design included perpendicular massive acrylic panels that constitute the above-grade southwest corner of the pool. It's a daring design, to say the least. Aesthetically the concept is to visually link the beautiful interior of the pool with the scenic setting. Technically speaking, it required creative problem solving, custom fabrication and ultra-precise installation.

The concise explanation is that the acrylic panels had to connect, bond, and function as one structural vessel. Making that happen pushed our existing norms to a new level.

Turns out that creating a fused L-shaped panel in our climate is far more challenging than we imagined. We had to create a watertight connection between the acrylic and the shotcrete, while allowing for differing thermal expansion and contraction in an area known for both very cold and very hot weather.

Through painstaking investigation, we determined that joining massive panels at corners like this requires a special caulk joint supported by a structure known as a mullion, a common fenestration term referring to vertical supports in window treatments. In this case, we were looking at what might rightfully be considered a mullion on steroids.

We had never tried this before, so we brought in our friend and colleague, Rick Chafey from Red Rock Pools & Spas in Chandler, AZ, who had experience in this type of challenging application.

We designed the mullion with Chafey's guidance and design input. It was fabricated from ¾ in. and 1 in. (19 and 25 mm) stainless steel fin-shaped plates that buttressed the joint in both directions. The idea was to create a support structure for the loading and push of the interior water.

The mullion was set into the concrete with ¾ in. threaded rods. The bottom and sides of the panels were set 10 in. (250 mm) into a channel in the concrete, with caulking around both sides of the panel. The force of the water acts to make the ends of the walls lift, so we also used stainless steel panels on the tops of the walls, finishing them with Bisazza glass tile.

We knew we'd have to closely monitor the structure during the first winter and determine how to service it for the next. We wanted to collect data to get this down to a science as there was no previous experience to support the performance characteristics of two 7 in. (180 mm) thick, acrylic panels joined together in a swimming pool here in the northeast climate.

This completed water shape is proof positive that the shotcrete process not only creates a watertight bond to support vastly different surfaces, but it is also well-suited for

use in projects featuring leading architecture and design. The experience and creativity of a quality shotcrete can be an integral part of creating meaningful architectural works that stand the test of time.

William T. Drakeley *is principal and owner of Drakeley Industries and Drakeley Pool Company in Bethlehem, CT. He holds the distinction of being the first pool builder to sit as a voting member of the American Shotcrete Committee 506 – Shotcrete, and he serves as secretary of the ACI C660 Nozzleman Certification Task Group. He is a co-founder of, and instructor for, Watershape University, teaching courses on shotcrete application at numerous trade shows. Drakeley is a valued contributor to WaterShapes, Shotcrete Magazine and other industry publications.*

Hot Weather Shotcrete

By William T. Drakeley

Wetting of the entire cast or shot surfaces is essential

Placing shotcrete in hot weather can be a risky proposition if you don't follow basic guidelines. Success under these conditions, calls for controlling concrete temperature and mixture design while also managing details of the installation and curing processes.

The summer is always busy, but that may be a huge understatement this year. The country is coming back to life with consumers very aware of their personal space and wanting to do more with it – which, often times means adding watershapes.

As a result, the heightened demand for our pool industry's products will likely lead to all sorts of logistical and supply issues. The availability of concrete may well be one of those critical issues. Ready-mix suppliers have informed me that during this forced downtime, many homeowners, do-it-yourselfers, are taking on their own concrete work. Suppliers caution that when the contractors fully come back online during the summer, there could be delays in product supply and even shortages of ready-mix delivery trucks. To varying degrees, it's often true that hot weather and elevated temperatures drive up demand.

Especially with the current extraordinary circumstances, the first step in hot-weather concrete work, whether you're doing wet-mix or dry-mix shotcrete, is you need to communicate with your concrete material suppliers and place orders well in advance. That's the only way you'll

Wetting down freshly shot walls after finishing

know what to expect for availability and delivery, so you can schedule accordingly and in turn let the client know what to expect.

Beyond that basic caveat, there are specific measures and conditions required whenever you're placing concrete in hot weather. Shotcrete placement in hot weather requires temperature control, environmental control, and jobsite control.

ENVIRONMENTAL CONDITIONS

I currently serve as Chair of American Concrete Institute's (ACI) 506-H Pool Shotcrete Committee. We are writing guidelines for the shotcrete placement process, as it pertains to both wet- or dry-mix for pools. In the hot weather shotcrete section, we refer to the existing hot weather concreting documents from ACI 305, which define acceptable concrete temperatures and procedures.

According to the ACI 506 pool shotcrete document, you should always keep concrete as cool as possible. You should not apply shotcrete when ambient temperatures are over 95°F (35°C), unless special precautions are taken. The precautions should be reviewed by the pool designer or other experienced engineer. You can cool the concrete by using cold water to mix it, misting systems, wetting blankets, and shade. Each of these options slow down evaporation and help reduce the potential for early age plastic shrinkage cracking on the surface of the concrete.

Considering what's happening in the fresh concrete matrix helps explain why these measures are necessary. When you mix water with portland cement hydration occurs. The cement hydration produces changes in the cement particles that lead to strengthening as the particles interlock. The hydration process leads to a volumetric change in the concrete, as well as additional heat from the chemical reaction.

When you're already working in warm conditions, you can easily wind up generating too much heat if you're not taking measures to cool down the environmental temperatures and the concrete itself. If temperature of reinforcement, embedments, or forms is greater than 120°F (49°C), use a fine mist of water to moisten and cool hot surfaces. Remove standing water before shotcrete placement.

Yes, it is possible to successfully place shotcrete in temperatures over 105°F (41°C) or even higher – consider Arizona and Nevada. But you must take recommended precautions. Do everything you can to avoid the heat of the day by working in the morning, if possible. You may also consider erecting a shade structure to keep the concrete, forms and reinforcing out of direct sunlight.

TIMELY APPLICATION

Shotcrete is very time-sensitive and that's particularly true in hot weather. Whenever you see a concrete truck on site, spinning and mixing the concrete you're watching a clock ticking. Under normal conditions, with no added measures, you have about 90 minutes from the time the water is added to the truck until you get it into place. All things being equal, that timeframe shortens in hot weather.

You may consider adding water to the concrete in the ready-mix delivery truck to cool the mixture and slow down the hydration process. This may seem like an easy way to extend how long you have to shoot, trim and finish the concrete in place. But DON'T do this, you're increasing the water-to-cementitious ratio (w/cm), reducing the concrete's strength, increasing the permeability and ultimately producing a pool shell that is less durable.

Maintaining the right w/cm is another key factor to keep in mind, especially in elevated temperatures. The w/cm is driven by the application. Where you want dense, low permeability concrete that will better resist environmental issues such as corrosion from saltwater exposure, you go with a 0.40 ratio. That doesn't have as much water to dilute the hydrating cement as one may see in a more typical 0.50 ratio used in concrete flatwork.

So, how can we produce a concrete mixture that slows down the setting time in warm weather? In addition to physical measures to keep things cool, you can use concrete retarding admixtures that can stretch the time-frame to three hours without compromising strength.

There are also hydration control admixtures (sometimes called "set stabilizers"), such as MasterSet DELVO that can suspend the hydration process for a set time, enabling us to extend the time for using the ready-mix concrete to four or even five hours. Not only do hydration control ad mixtures help in hot weather, they can also be extremely helpful where delivery takes a long time for whatever reason.

Cracking in the concrete pool shell from inadequate curing will mirror through the plaster coating.

Partial wetting is not acceptable. All exposed concrete must be kept continuously wet for 7 days.

Say you have a job where it takes more than two hours for the ready-mix truck to reach the jobsite, using hydration control you adjust the dosage, so the concrete arrives as if it was just batched and gives you the maximum workability on the job without reducing the concrete strength.

Different chemicals and supplemental cementitious materials (SCM) will impact hydration and set times at different rates, therefore you should understand the performance characteristics of the products being adding to the mixture, whether they are set retarders, hydration control, high-range water reducing admixtures, or SCMs like fly ash, slag or silica fume. As you alter the chemistry and composition of the concrete mixture, you need to be aware of its impact on workability and set times.

READY TO WORK

Just as scheduling becomes a critical issue in hot weather, the same is true of mixture design. Most concrete suppliers know their own products and can easily adjust the mixture design to suit your needs and situation, but you must communicate your needs to them first! I lay it all out for them when setting up for the job. For example, I will tell the supplier, "Here's the thickness of the wall, the reinforcing steel schedule, how far the job site is from the batch plant, how far we have to pump it, the anticipated temperature range we'll be working in and the desired compressive values and durability factors." I'm always looking for the best mixture design for each particular situation so that we will get the concrete placed properly and creating the best structure in place. If you don't consider all the factors in the concrete mixture design, you may have concrete with insufficient compressive strength, lower density, excessive shrinkage cracks or other problems.

While the concrete mixture design is all about preparation and forethought, the same is true when it comes to orchestrating the physical work onsite. When we're working in hot weather, it's a very carefully choreographed process. We have guys wetting down the steel, finishing the concrete immediately using trowels and radius boards, and then wetting down the hardened concrete to slow down evaporation and reduce the potential for early age plastic shrinkage cracking.

Hot weather concrete placement takes planning and experienced crews. This is no place to train a rookie because you've got to move fast and work efficiently to stay ahead of the setting of the concrete and maintaining moderate temperatures. Everything is more time-sensitive and unforgiving, making for a more challenging process on site where you must keep moving or risk a failed structure.

Time and time again, we've seen situations where the contractor was careless. They weren't managing the temperature with misters or wetting the surface after finishing. They didn't plan ahead to control the chemistry of the concrete mixture. It was a blistering hot day and they didn't cool down the reinforcing steel and substrate. Or the concrete set too fast and they didn't get the work done in the right time frame. When you see those missteps, the pool will crack, often before the plaster is installed and there will be a range of cosmetic and often structural issues for the life of the pool.

IT'S CURED

Finally, curing is another crucial part of the process that can be dramatically impacted by high temperatures. ACI defines curing as action taken to maintain moisture and temperature conditions in a freshly placed cementitious mixture to allow hydraulic cement hydration and (if applicable) pozzolanic reactions to occur so that the potential properties of the mixture may develop. ACI recommends a minimum of 7 days curing time. For shotcrete, our committee recommends

keeping the surface constantly wetted for seven to 7 days as a bare minimum.

During the curing process, your goal continues to be to provide water to the unhydrated cement in the concrete to build strength and produce lower permeability. In hot weather, you need to be aware that the curing process will need to be accelerated (due to evaporation) and if it goes unchecked, the strength of the concrete may be reduced.

As is true during concrete placement, during curing you encounter heat from two sources -- the chemical hydration reaction and the environment. You must rigorously follow curing guidelines to keep the moisture in the concrete mix. It is well established that if you keep the concrete wetted for 7 days, you'll be significantly increase compressive strength. It's not unusual to find concrete that has a specified 28-day compressive strength of 4000 psi (28 MPa) breaking at 4,000 psi and higher after just 7 days of curing. The basic fact is the longer you water cure concrete the stronger it becomes, will have a lower permeability and ultimately last longer. If, on the other hand, you don't follow the curing protocol, the strength will be far, far less. It absolutely destroys the compressive value.

Moisture can be maintained by sprinkling, flooding, fog, or by covering with continuously moistened canvas, cloth mats, straw, sand, or another approved material. Wood forms left in place during the curing period should also be kept wet. Formed surfaces should be thoroughly wetted immediately after forms are removed.

If you're in an area impacted by drought, we recommend using damp burlap that is kept wet to keep the concrete surface wet. Alternatively, a sprinkler hose will work just fine but will use more water. Either way, you have to keep it wet and keep it cool.

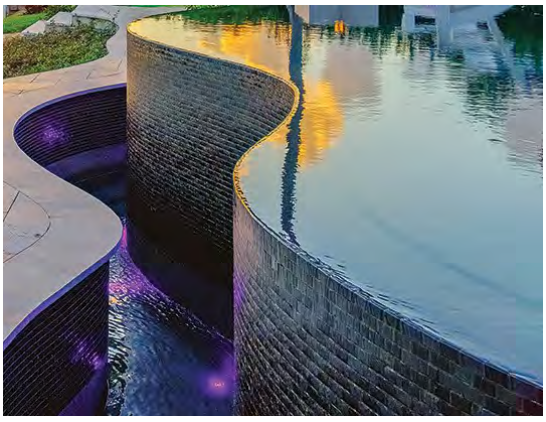
If you follow the basic guidelines discussed above, you'll wind up with a pool shell with high compressive values and minimal cracking.

The bottom line is when you're working high temperatures you must follow expert guidelines. Slowing everything down when it's hot is not always the easiest thing to do, but in the world of concrete placement, it's absolutely necessary.

William Drakeley *is principal and owner of Drakeley Industries and Drakeley Pool Company in Bethlehem, CT. He holds the distinction of being the first pool builder to sit as a voting member of the American Shotcrete Committee 506 – Shotcrete, and he serves as secretary of the ACI C660 Nozzleman Certification Task Group. He is a co-founder of, and instructor for, Watershape University, teaching courses on shotcrete application at numerous trade shows. Drakeley is a valued contributor to WaterShapes, Shotcrete Magazine and other industry publications.*

What Dreams Are Made Of

By Eric Herman



The desire to escape and recognizing that one's own backyard can be that place of refuge is a notion that has gained much traction during last year's COVID shutdown and the "work from home" trend. Recognizing how collaboration is key to creating such a refuge has been at the core of Holland Aquatics' business from the beginning. This is an interview with owner, Brett Holland, as he walks us through this approach on one such project built in 2018.

Born and raised in Florida, the Sunshine State, Brett Holland grew up at the side of his late father, Mike Holland, learning not only how to build beautiful pool/spa environments, but equally important, why it is imperative to include the clients in the design process.

"Some of my fondest memories of my father were poolside," recalls Brett. "He showed me how important it is to look at the work from the client's point of view. I find most people hardly spend any time out back, yet the ultimate goal is to extend their living area into the backyard. By adding a water shape to the property, we create a place of serenity where memories grow."

This project, completed in August 2018, is a perfect example of that approach.

DESIGN CONNECTIONS

The property is located on the Loxahatchee River in Tequesta, FL near Jupiter. Holland was one of four builders considered by the clients and his sensitivity to their ideas, as well as his collaborative approach, won them over.

"I always design with my clients," he says. "I may try to guide them toward certain decisions, but it's a collaboration from start to finish. In this case, it was definitely their

dream to live on the water, own a pool and ultimately make their dreams of the Florida lifestyle a reality. It's an extremely personal process and it takes a lot of effort. The homeowners become emotionally invested in the process and ultimately the end results. On this project, we're all very proud of what we achieved by working together."

The property had an existing fiberglass pool, decking and a retaining wall, all of which were removed prior to the construction of the new pool.

"We looked at a number of different ideas. It turned out that the clients favored a freeform design that felt more tropical," Holland says. "They also wanted to create a visual connection between the pool and the river's dark water, bringing the water as close to the house as possible, which is why we included the vanishing edge and perimeter-overflow detail."

The pool is 14.5 ft (4.4 m) wide by 36 ft (11 m) long, with a combination vanishing edge and perimeter overflow. An 8 ft (2.4 m) diameter circular spa is located inside the pool, raised a paper-thin 1⁄8 in. (3.2 mm) above the pool's surface. The edge treatments and dark finish colors harmonize with the dark waters of the river to serve as a mirror reflecting the dramatic Floridian cloudscapes.

"It was very important that we maintain a glassy surface," he recalls. "If the surface was turbulent, it would disrupt the visual we were trying to achieve. So, we were very careful where we placed the floor returns. On the sun shelf, we ran a separate line to the floor returns on ball valves, allowing us to fine-tune the flow on the shelf to prevent it from roiling the surface. That was also why we went with the spa inside the pool with the finish level of the tile just as close to the pool's water as possible. It was all because we wanted that smooth, glass-like appearance over the entire surface."

EMERGING DETAILS

Vantage points influenced almost all aspects of the design, including the most basic question of where to locate the pool relative to the house. To maximize the visual connection between the pool and the river, Holland carefully studied each angle, including the view from inside the house itself.

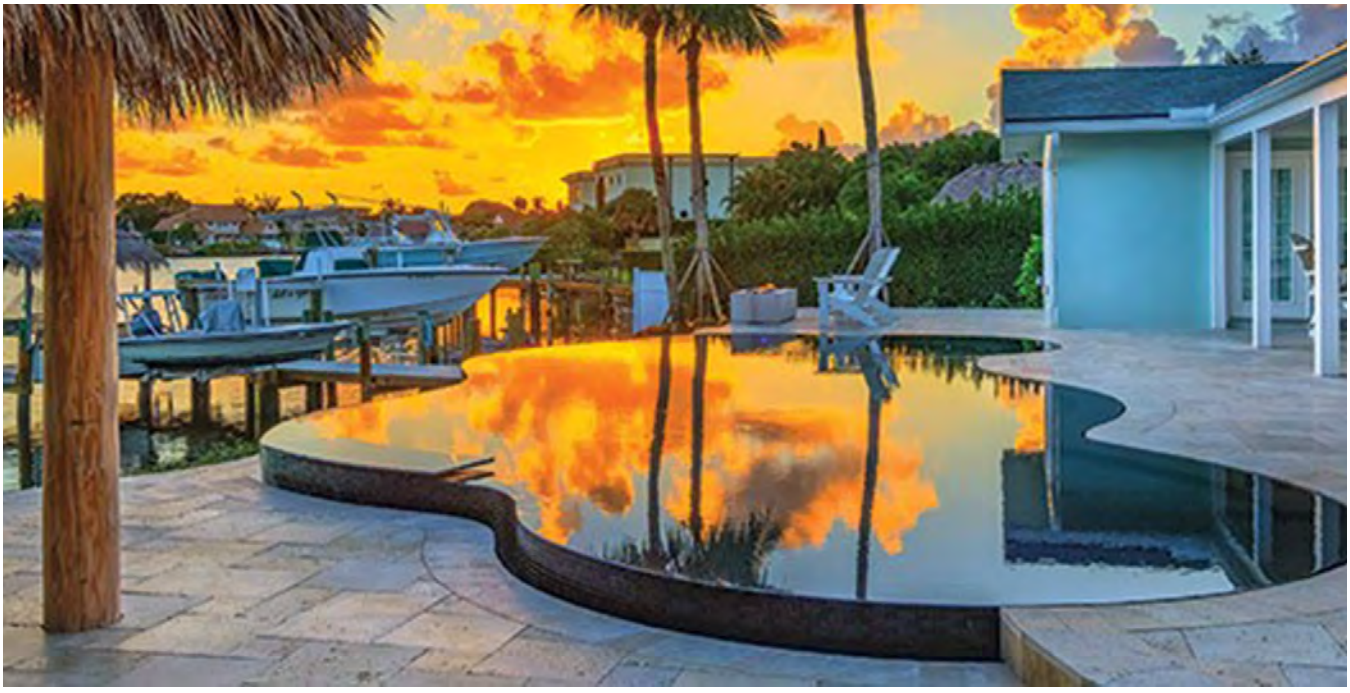
The primary vantage point is actually from the living room where you look out over the pool through a series of sliding glass doors," he says. "We had to be very deliberate in where we set the elevation of the pool and how far back from the river, so you don't ever see any part of the sea wall. We double-checked the elevation, at the time of forming, with the client to make sure this critical detail was spot on."

Views within the setting also came into play during the design phase. For example, the client wanted a thatched tiki hut with a large TV located beside the pool. That led Holland to suggest including a "floating bar top" with a pair of barstools to allow swimmers to watch TV from the pool.

The bar top detail was set on the perimeter overflow, designed to appear as though it was floating on the edge of the water. The slight elevation difference between the pool and the deck at that location, presented a low water wall effect for those staying dry beneath the hut. The dark granite bar top was elevated slightly to prevent it from disrupting the flow over the edge.

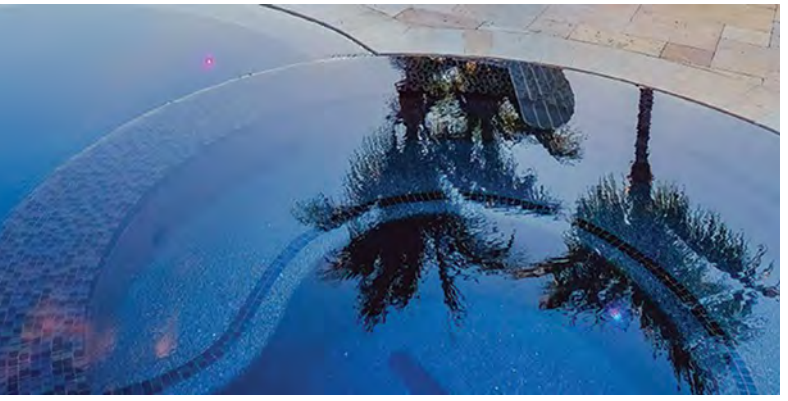
WATER IN TRANSIT

The most significant design detail involved the edge treatment that combined the vanishing edge on the far side of the pool with a perimeter overflow that flows around the other sides of the vessel. Combining these two water-in-transit features required some creative thinking and clever engineering.



For example, the backside of the spa needed to flow into the perimeter overflow trough even when the vanishing edge was not activated. That's important because the perimeter overflow trough flows into the catch basin. That meant the system had to be plumbed to constantly draw water from the basin, both when the vanishing edge is operating and when it's not.

The edgework also meant ultra-precise form construction and leveling. "On all of our edge



projects, we fill up the pool with water to set the final elevation on the edge," he says. "That level has to be as precise as possible and can shift with the weight of the water. Also, because we were finishing the edge in a pebble finish, we had to calculate a small amount of head in the flow over the edge to compensate for the slight variation in the small pebbles. In this project, we set it up for 3/16 in. (4.8 mm) flowing over the edge. The execution by Joseph Palma, owner of Treasure Pools, and his team was nothing less than exceptional from start to finish. You can design a masterpiece, but if it's not executed properly, the true vision will never see fruition."

The perimeter overflow trough was made on-site with precisely placed dry-mix shotcrete. It featured 3 in. (75 mm), horizontal "knockout" lines from the trough that fed a 6 in. (150 mm) trunk line which in turn dropped down into the catch basin on both sides of the pool. The knockouts in turn help minimize the noise coming off the slot by the tiki hut. "We could have designed the trough to handle the water in transit off the edge, however, it would have been extremely noisy falling into the basin," he explains.

LIGHT, DARK & SHIMMERING

Selecting finish materials included long and detailed discussions with the clients, a process that ultimately led to a palette using contrast to accentuate the pool's shape and enhance reflections.

The light end of the spectrum came courtesy of the French-pattern travertine decking, which wrapped around all sides of the pool, including a pathway that ran between the edge of the catch basin and the river's edge.

The pool's interior was finished in a custom blend midnight pebble finish from Stonescapes. Holland expressed his dissatisfaction in the past with the appearance of dark exposed aggregate finishes because the cement background color provided too much of a contrast with dark pebbles. So, in this case, we dyed the cement a dark gray instead of the standard blue so that it would have a more uniform dark appearance.

Holland also added abalone shells to the mix to give the dark finish a shimmering quality that becomes almost iridescent in direct sunlight. "But we didn't want the vanishing edge to sparkle because we wanted it to blend with the dark water of the river," he says. "So, we started out finishing the edges without the abalone, and then added it in the mixture when we started on the floor and the walls."

The spa beam and outside surface of the vanishing edge and wet walls were surfaced in a black glass tile, which added a layer of rich optical interplay. "It's a beautiful look, but we had to be sure there wouldn't be any efflorescence later on," he explains. "We see that all the time with tile finishes and it can ruin an otherwise beautiful pool. That's why we sealed the entire shell using Aquron waterproofing, which does a great job of preventing efflorescence and other problems associated with water moving through the shell."

The dark materials take on a different optical character at night with the pool's extensive use of nicheless LED lighting fixtures. These small lights provided detailed illumination of the vanishing edge wall with its 1-by-2 in. (25 x 50 mm) black glass tiles, as well as lighting in the floor of the sun shelf.

A NEW GENERATION

As mentioned above, Holland was raised in the pool industry, initially working with his dad in the Orlando area. At this writing, Holland is moving back to his hometown where he'll work with his cousins Ryan and Wes Holland. The journey back to his roots closes a big loop in his early career and has given him cause to reflect on the skills and wisdom he gained from his father, Mike Holland, who passed away two years ago.

"I think my Pop would be proud," he says. "I learned a lot from having the opportunity to work for several different companies, but my dad was the one who taught me how to build a pool and to appreciate what it means to the homeowner, and how a well-designed swimming pool can make people's dreams come true." An example where the collaboration of dreamer and dream maker can create something magical for all involved.

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Failures of Trust

By Dave Peterson & William T. Drakeley

Fig. 1: Dry mix, low w/c ratio, low cementitious content, water added to floor

Engineers carry an almost sacred trust, with watershapers relying on them to design structures and systems that are reliable, science-based and code-compliant. When that trust is broken, the consumer's investment is at risk -- as is the watershape builder's reputation.

Engineers are highly trusted. In a recent Gallup poll asking which professions are the most trusted, nurses were number one and engineers came in second. Engineers placed above medical doctors, police, psychiatrists and clergy. Not surprisingly, used-car salesmen and members of Congress were at the bottom of the polls!

That high level of public trust begs the question of whether or not engineers truly warrant such rock-solid credibility? Engineers are not all the same and certainly when considering the profession, most are trustworthy, practicing ethically and responsibly. However, there are some that most assuredly are not. Unfortunately, a clear and compelling example of less than responsible engineering can be found here in the pool industry.

When you obtain a set of plans from a consulting engineer – a structural design, for example – you have every right to believe that their calculations, specifications and plans are properly prepared and correct for the project at

hand. In most cases, that trust is well-founded; but there are some glaring exceptions.

You run into problems with what we call “mail order” or “off the shelf” plans developed and sold by a few engineering firms. By packaging generic plans, these firms enhance their profits while dumbing down their specifications and allow builders to cut corners.

Some people refer to these as “standard plans,” which is a euphemism and misnomer. No two pools are exactly alike. The soils are never exactly the same, nor the property, the environmental conditions, and certainly not the homeowners. Therefore, there really is no such thing as a standard plan. We believe engineers that market plans as such are not meeting the standards required of true professional engineers.

PERPETUATING MYTHS

The unfortunate fact is, many pool builders will use an engineer’s generic design, plans and specifications if they think it will lower the cost of the pool, when compared to more rigorously engineered plans designed for a specific pool project. Some builders will ask, why should I use #4 (#13M) reinforcing bars when this engineer says I can get away #3 (#10M)? Mail-order engineers give them the answer they want.

In other words, not all engineers should be trusted. Some of the lowered standards you see in mail-order plans do, in point of verifiable fact, lead to failures or produce a final pool structure that is much less durable. The fact that the engineer’s plans and resulting structure was not engineered for the specific conditions of a particular site only becomes known, all too often, in the discovery phase of an expensive and time-consuming lawsuit.

The ugly truth is, there are engineers who will lie to you because they’re more concerned with their bottom line than they are with their responsibility to prepare proper designs as expressed in the integrity of their plans. They may ignore some ethical codes while seeking profits.

The good news is it’s often easy to spot an unscrupulous engineer in the pool construction industry if you know what to look for. Usually, the corners they cut will be obvious in their project deliverables.

In our industry the biggest area of deception is concrete and reinforcement. They cut corners in the compressive strength and permeability of concrete, cover over the embedded reinforcing steel, the size and spacing of reinforcing steel and even the thickness of the concrete. They attempt to get away with it by using clever language that’s meant to confuse builders and authorities having jurisdiction.

One of the arguments, for example, is that it’s okay for concrete to be permeable, because that’s the plasterer’s job. Builders don’t have to worry about water permeating the concrete shell because the plaster is there to stop it. Well, that’s just not true. A properly designed and constructed concrete pool shell should be functionally watertight.

Fig. 2: Thin wall shotcrete, insufficient concrete placement and no encapsulation of surrounding penetrations or steel reinforcement

The National Plasterers Council, for example, is clear that plaster is not a waterproofing coating or membrane. They require their product to be applied to a watertight concrete shell. That’s because water that makes it through the plaster will flow more readily through a porous shell. Once that happens you can have all sorts of problems, including corrosion of the reinforcing steel or even through wall leakage, compromising the soil around the outside of the pool shell.

We often see similar shortcuts with specifying concrete cover over the reinforcing steel, which is essential to structural integrity, and long term durability of the pool shell. If there’s inadequate cover, water can penetrate to the reinforcing steel and initiate corrosion that may spall the concrete off and could lead to expensive repairs. The same is true with under sizing the reinforcing steel. The reinforcing must be designed for all expected loads the pool shell will experience in its lifetime. This includes containing the water, standing against backfilled soil loads, surviving seasonal temperature swings and concrete shrinkage. As an example, using #3 bars at large spacing horizontally is not sufficient in many situations to properly carry the internal stresses from thermal changes and concrete drying shrinkage for an empty pool. Sub-standard plans may also cut corners on specified concrete wall thickness based on

March 11, 2014
AC-4954

CORE NO.	THICKNESS	LOCATION
5	7 1/4"	Bottom - 13'6" W 14'8" N of SE Corner of Trough
6	9 5/8"	Bottom - 17' W 13' S of NE Corner of Trough
7	13 1/2"	Steps - 13'3" W 3'1" N of SE Corner of Trough
8	13"	Steps - 15'6" W 3' S of NE Corner of Trough

Date Sampled: 2/24/14 Date Tested: 3/6/14

Specimen Identification:	Core #5	Core #6	Core #7	Core #8
Core Location:	Bottom	Bottom	Steps	Steps
Core Diameter (in.)	3.72		3.74	3.73
Core Area (sq. in.)	10.87		10.98	10.93
Length Before Capping (in.)	6.75		7.38	6.88
Length After Capping (in.)	6.94		7.63	7.00
Compressive Strength, psi	2765		2030	2429
Maximum Load (lbs.)	30,050		22,260	26,550
Length/Diameter	1.91		2.04	1.89
L/D Corr. Factor	.98		--	.98
Corrected Compressive Strength, psi	2709		--	2381
Direction of Load applied relative to the horizontal plane of concrete as placed.	Vertical		Vertical	Vertical
Age at Test (days):	171		171	171
Moisture Condition of Specimen:				
During Curing	Moist	Moist	Moist	Moist
At Test	Surface dry		Surface dry	Surface dry
Nominal Aggregate Size:				
Defects in Specimen:				
Time Sample Taken:	11:08am	11:25am	10:55am	11:01am

Fig. 3: Typical report of compressive value test reports

using less than appropriate cover and ignoring the tolerances on placing the reinforcing steel.

THE BIG LIE

The most obvious and egregious shortcut, and the most deceptive, is found in the way that some engineers specify the compressive strength of concrete. This is an almost mythical area that's been perpetuated for years. Frankly, it's disturbing that this one still exists; but, when you look at the deceptive language, it's painfully obvious what's happening.

According to language provided by some mail-order engineers who specialize in pools, "Shotcrete shall have a minimum compressive strength of 2,500 psi (17 MPa)." But then in the next sentence, you'll read "where applicable, shotcrete shall conform with the IBC Section 1904 Durability Requirements."

First of all, where does IBC Section 1904 not apply? The fact is, all pools constructed using pneumatically applied concrete, either wet or dry-mix shotcrete, are subject to the IBC language. Well, guess what? The IBC is clear that concrete should have a minimum compressive strength of 4,000 psi (28 MPa), or 4,500 (31 MPa) or 5,000 (34 MPa) depending on specific soils conditions and exposures. Therefore, saying that the minimum compressive strength can ever be 2,500 psi is simply a flat-out lie. Saying, "where applicable" is nothing more than a way of distracting you from the fact that the IBC standards apply everywhere. The language in IBC 1904 is crystal clear that concrete structures shall comply with the American Concrete Institute's (ACI) 318 Building Code Requirements for Structural Concrete, which defines required compressive strength. It is unambiguous and there is simply no other way to accurately read the applicable Code language.

The reason for the misrepresentation of reality is that these untrustworthy engineers can sell more plans to builders looking to shave costs. If you build 35 pools each year and save $10 per cubic yard of concrete, some builders will see that number adding directly to the bottom line. And, courtesy of these untrustworthy engineers, they have a plan prepared by an "engineer" to point to that seemingly justifies the lower standard.

Cutting to the chase, any engineer that pushes the 2,500 psi standard is betraying your trust. Lower concrete strength creates higher permeability, less ability to protect the embedded steel reinforcement, and thus gives the owner a much less durable pool. And consider this, they are certainly not going to pay for repairing or replacing the pool when it fails to meet the owner's expectations for a durable, serviceable concrete pool shell that should last 50 years or more. Your clients are not going to be happy later on when in the course of a lawsuit they find out that the requirement really was 4,000 psi and you didn't take the time to discover that fundamental fact.

There are differences in the ACI 318 standard based on the type of exposure conditions but even a cursory review of the applicable code language in ACI 318, reveals there are no circumstances where 2,500 psi concrete is acceptable for concrete intended to be watertight.

The bottom line is that watershapes are required to have:

- 4,000 psi, minimum,
- 4,500 psi for freeze-thaw environments,
- 5,000 psi for high sulfates in the soil, and
- 5,000 psi for pools using saltwater chlorine generation.

Any specification or project plan that deviates from that is technically not meeting the code requirements. From our perspective any engineer claiming a 28-day compressive strength of 2,500 psi is acceptable is guilty of negligence, and misrepresentation. They are in effect facilitating the pool builder's desire to keep costs low and as a result allowing them to produce a pool that has nowhere close to the strength, serviceability and durability the pool owners should rightfully expect from their pool.

Fig. 4 Extensive efflorescence from cracks in pool shell due to design and construction issues.

POROUS ARGUMENTS

As mentioned above, concrete in pool shells should be functionally impermeable. That can be confusing for some people. It's a point that some engineers will use to their advantage because all concrete is, to some degree, permeable. To make sense of this issue, you need to understand four key terms when considering concrete:

- Permeable: having minute spaces or holes through which liquid or air may pass. All concrete is permeable.
- Porosity: the ratio, usually expressed as a percentage of the volume of voids in a material to the total volume of the material, including voids.
- Permeability: the ability of a given concrete to permit liquids or gases to pass through. All watershapes should be impermeable!

While it is true that all concrete is permeable to some extent, in 4,000 psi concrete the permeability is low enough that water flowing through the pool shell is not a problem. When you deviate from that standard and accept some lower compression strength, then it is very likely you'll have concrete that will allow water to permeate through it. One of the arguments you hear from some mail-order engineers is that the concrete matrix is inconsistent and there will inevitably be areas of higher porosity than others. Again, that is simply not true. With proper mixing and application techniques, concrete is relatively uniform.

In conclusion, engineers who support cutting corners and work outside of established and accepted industry standards are not worthy of your trust. Caveat emptor. Let the buyer (you, the builder) beware.

***David J. Peterson**, P.E, IWI, is co-founder of Watershape University and president of Watershape Consulting, Inc.*

***William (Bill) Drakeley** is principal and owner of Drakeley Industries and Drakeley Pool Company in Bethlehem, CT. He holds the distinction of being the first pool builder to sit as a voting member of the American Shotcrete Committee 506 – Shotcrete, and he serves as secretary of the ACI C660 Nozzleman Certification Task Group. He is a co-founder of, and instructor for, Watershape University, teaching courses on shotcrete application at numerous trade shows. Drakeley is a valued contributor to WaterShapes, Shotcrete Magazine and other industry publications.*

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Compressive (Strength) Values of Pool Shotcrete

Pool and shotcrete contractors have a responsibility to provide a pool structure that not only meets certain design specifications, but also meets basic durability values expected with shotcrete applications. The American Shotcrete Association's (ASA) Pool and Recreational Shotcrete Committee and ASA Board of Direction have reaffirmed a 4000 psi (28 MPa)minimum for in-place compressive strength pool concrete.

Concrete in field installations has a variety of different exposure conditions. Concrete used in water-retaining pool and recreational structures is expected to have a low permeability under any potential exposure. The American Concrete Institute (ACI) CODE 318-19, "Building Code Requirements for Structural Concrete," durability requirement provisions for concrete are covered in Chapter 19. ACI 318-19 specifies a W2 exposure category and class for, "Concrete in contact with water where low permeability is required." Table 19.3.2.1, requirements for concrete by exposure class, requires for a W2 exposure a minimum compressive strength of 4000 psi with water-cementitious material ratios (w/cm) no greater than 0.50. These values are ACI 318-19 Building Code required minimums. Consideration of key factors will yield higher strengths when using shotcrete placement of concrete.

Normally, good-quality concrete placed by the shotcreting process will substantially exceed the 4000 psi minimum ACI 318 requirements. Key factors that increase the likelihood of the compressive strength significantly exceeding the minimum of 4000 psi have to do with the material itself and the high velocity (60 to 80 mi/hr [100 to 130 km/hr]) the concrete materials impact the surface. After being strongly accelerated by high air pressure in the nozzle, the concrete strikes the receiving surface with such force that it is compacted. This results in consolidation of all the concrete rather than the sometimes incomplete consolidation that can occur with form-and-pour concrete. Fully consolidated concrete provides greater strength and lower permeability than poorly consolidated concrete. The compacted, low-permeability concrete created by shotcrete placement is the ideal concrete for structures intended to be watertight.

The resulting structure's concrete porosity and resulting compressive strength will easily exceed 4000 psi using the wet-mix shotcrete process. Further, due to cement content and lower w/cm inherent in dry-mix (gunite) shotcrete, concrete compressive strengths will normally far exceed the 4000 psi (27.6 MPa) ACI 318 Building Code minimum. Barring significant errors in material batching in application of the shotcrete or in curing, one simply cannot avoid producing watertight shells with these higher compressive strengths. To further understand the properties of the shotcreted concrete, you must also analyze its material matrix on a particle-to-particle basis. Shotcrete mixtures differ from typical concrete mixtures.

With shotcrete, the aggregate size is decreased while the surface area of all aggregates/particles is increased. This increase in surface area demands an increase in the binder (cementitious materials such as portland cement, fly ash, and slag), that fills the voids between the aggregate and glues this matrix together. The resulting lower w/cm gives shotcrete its increased strength. Couple this matrix with proper velocity in placement (high velocity = full compaction = strength and low porosity) and you get 28-day compressive strengths ranging from 4500 to 9000 psi (31 to 62 MPa) or more.

In summary, properly designed concrete placed with the shotcrete process with in-place values less than 4000 psi is the result of an unintentional or intentional breakdown in concrete materials or shotcrete application. Though the pool industry has seen shotcrete specified with less than the ACI 318-19 Building Code required 4000 psi minimum 28-day compressive strength, lower strength could only result from significantly reduced material quality or poor shotcrete application techniques. Specifying a lower compressive strength would result in increased porosity of the in-place shotcrete and thus greatly reduce the pool shell's basic ability to hold water and its durability.

Unfortunately, the pool industry often suffers from the distribution of incorrect information on minimum compressive strength values of in-place shotcreted concrete. ASA continually works to educate all who are in and related to the pool industry regarding proper placement and in-place properties of concrete placed with the shotcrete process. ASA also works to ensure that the shotcrete industry understands and implements the guides, specifications, and codes of ACI and its shotcrete information. Together, ASA and ACI form the primary sources of shotcrete education

and documentation. We firmly maintain that the 4000 psi minimum 28-day compressive strength that meets the ACI 318-19 Building Code requirements is necessary to produce durable, watertight pool shells that our owners deserve and expect. Specifying any lower compressive strength does a disservice to the owner and the pool industry.

References

ACI Committee 318, "Building Code Requirements for Structural Concrete and Commentary (ACI CODE 318-19)," American Concrete Institute, Farmington Hills, MI, 2019, 623 pp.

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Position Statements

ASA has produced position statements on the best practices for proper shotcrete placement. To date, seven position statements from our Pool & Recreational Shotcrete Committee, two from our Underground Committee, and one from our Board of Direction have been issued. These statements have also been published in *Shotcrete* magazine.

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ASA POSITION STATEMENTS – POOL & RECREATIONAL SHOTCRETE COMMITTEE

The Pool & Recreational Shotcrete Committee first started publishing Position Statements in 2011. The concept of these papers originated from a great confusion in the shotcrete pool market. Correct terminologies, strength, performances, and so on were often unsubstantiated opinions without a basis in hard concrete knowledge.

The ASA Pool and Recreational Shotcrete Committee worked to establish reference benchmarks that are vital to builders who use the process. These positions are standards of practice for correct shotcrete placement. We encourage all pool builders and shotcrete contractors to use and apply references from the American Shotcrete Association (ASA) and the American Concrete Institute (ACI).

These resources allow pool builders to now have knowledgeable and credible associations supporting their efforts to properly shotcrete pools. To date, seven ASA Position Statements have been issued by the Committee. ACI Technical Committee 506 is developing a "Guide to Shotcrete Use in Pool Construction". ACI recently established a new Code committee (ACI 322 Pool & Watershape Code Committee) to specifically address design requirements for concrete pools.

After ten years, we are reissuing some of our Position Statements where references needed updating. The first two you'll find in this issue. Today more than ever, our market is seeing unprecedented demand and the need for close adherence to the proper shotcrete placement to ensure that quality and durability is not sacrificed in the race for quantity.

Watertight Shotcrete for Swimming Pools

Shotcrete is an ideal construction method for a concrete swimming pool. The versatility of shotcrete placement allows for the construction of a concrete pool shell of virtually any size and shape. Standards for shotcrete design and applications can be found in American Concrete Institute (ACI) Committee 506 guides[1], specifications, and technical notes, as well as ASA position papers.* Responsible shotcrete contractors specializing in concrete pool construction must use appropriate design, quality materials, and construction techniques to build a fully functional pool with long-term durability that is functionally watertight under normal service conditions. Watertightness of the shotcrete material is a crucial durability and serviceability property of any properly con structed water-containing shotcrete structure. Shotcrete placement that allows water to pass through the concrete of a pool shell is a sign of flawed material or placement techniques.

Pools are complex concrete structures with irregular shapes, varying thicknesses, numerous shell penetrations, and variable soil conditions. The structural requirements for a pool shell must be evaluated by a professional engineer who is qualified for structural evaluation. A proper design will include specifications for subgrade preparation, concrete shell thicknesses, concrete materials, reinforcing steel layout, and pipe and fixture penetration details. With an appropriate design, proper materials, and quality placement, the experienced builder creates a pool that meets loading conditions, provides long-term durability, and is functionally watertight.

The concrete material used to construct the pool shell must meet watertightness requirements. Scientifically defined, watertightness of the concrete material is the result of complex mass transport mechanisms (capillarity, permeability, and water diffusion) that refer to various properties of concrete[2] A definition of watertightness is "impermeable to measurable flow of water except when under hydrostatic pressure sufficient to produce structural discontinuity by rupture."[3]

A proper concrete mixture design is a prerequisite for successful shotcrete application of concrete. A well-designed, shootable mixture should be selected with a proper aggregate gradation, allowing it to pass through a shotcreting system. Special attention should be given to the amount of fine aggregate and cementitious paste necessary to cover the aggregate surface area (minimum 4:1 cementitious-to-aggregate ratio, and ideally 3:1). Sufficient cementitious paste and a low watercementitious material ratio (w/cm) are necessary for producing a dense, watertight final product with full encapsulation of embedded reinforcing.

Assuming the correct mixture design, compressive strength of the concrete is generally indicative of the w/cm (lower w/cm equates to higher strength and lower permeability) and the potential watertight- ness of the shotcrete in the pool shell. Complete compaction of the pool shell concrete is a direct result of the high velocity (typically 60 to 80 mi/hr [100 to 130 km/hr])[4] the concrete mixture is shotcreted onto the receiving surface. The high impact energy produced by proper shotcrete equipment and placement techniques achieve maximum in-place encapsulation and compaction with minimum voids for a given concrete mixture. Compressive strength is measured through core samples taken from in-place material or shotcrete test panels. Because concrete compressive strength is affected by the same physical properties that affect watertightness, it is possible to evaluate the quality of a shotcreted pool shell—both from a structural and a watertightness point of view—by considering the compressive strength of the shotcrete produced. Thus, in this context, compressive strength is an appropriate predictor of watertightness.

Shotcrete made from properly graded aggregates, quality cement, and potable water; properly placed by a qualified shotcrete crew; consolidated at the requisite velocity; and properly cured will easily yield a 28-day compressive strength of 4000 psi (28 MPa). 5000 psi

*NOTE: "Shotcrete" and "concrete" are two distinct terms. Shotcrete is defined as "concrete placed by a highvelocity pneumatic projection from a nozzle."[3] In other words, concrete is the **material**; shotcrete is the placing process. The end result is a concrete structure built with the *shotcrete* process. However, many members of the industry will use the terms interchangeably *when the reference to the shotcrete process is implied*. We do the same in this position statement, using "shotcrete" and "concrete" interchangeably. A "shotcrete pool shell" is understood to be comprised of concrete, and a "concrete pool shell" is—in this context—understood to have been placed using the shotcrete process.

(34 MPa) is desirable for enhanced durability and is routinely achievable by careful attention to materials and placement techniques.

Table 4.2.2 of ACI CODE 350-06[5] has specific code requirements for special exposure conditions. The table indicates concrete intended to have low permeability when exposed to water should have a maximum w/cm of 0.45 with a minimum 4000 psi compressive strength. However, when the concrete is exposed to chlorides (brackish water, salts, and seawater), ACI 350 requires a maximum w/cm of 0.40 and compressive values of 5000 psi (34 MPa) to provide protection for embedded reinforcement. Thus, lower w/cm and higher compressive strength provide better protection for embedded reinforcement in water containing structures. Concrete technology and common-sense show that watertightness will be improved using a concrete with a low w/cm with sufficient paste content—that is, well consolidated by the placement techniques and properly cured and protected after placement—thus creating a dense functionally impermeable concrete.

There are many reasons why a shotcrete placement would not achieve specified minimum compressive strength. These include poor workmanship, defective equipment, unfavorable environmental conditions, or the inadequate selection of ingredients including poorly graded aggregates, soft or deleterious aggregates, expired cement, or contaminated water. In any case, compressive strength values less than 4000 psi are, in most cases, the result of intentionally or unintentionally ignoring the rules of good practice 6,7 and will result in pool shell shotcrete that is not watertight.

As with any other concrete structure, shotcrete pool shells must be properly designed—both from a structural and a concrete material perspective. Good quality shotcrete properly designed, manufactured, placed, and cured will produce the desired result—a durable and essentially watertight structure. Experienced pool builders pay attention to all the details of the shotcrete process and building pool shells with watertight shotcrete. Watertightness of shotcrete should be the expectation of all parties: the client, the designer, and the contractor.

TABLE 4.2.2—REQUIREMENTS FOR SPECIAL EXPOSURE CONDITIONS

Exposure condition	Maximum water-cementitious materials ratio, by weight*	Minimum f_c', psi*
Concrete intended to have low permeability when exposed to water, wastewater, and corrosive gasses	0.45	4000
Concrete exposed to freezing and thawing in a saturated condition or to deicing chemicals	0.42	4500
Concrete exposed to corrosive chemicals other than deicing chemicals	0.42	4500
For corrosion protection of reinforcement in concrete exposed to chlorides in tanks containing brackish water and concrete exposed to deicing chemicals, seawater, or spray from seawater	0.40	5000

*A lower water-cementitious material ratio or higher strength may be required for durability of concrete exposed to sulfates (Table 4.3.1).

Fig. 1: Table 4.2.2 of ACI CODE 350-06 Requirements for Special Exposure Conditions

References

1. ACI Committee 506, "Guide to Shotcrete (ACI PRC 506-16)," American Concrete Institute, Farmington Hills, MI, 2016, 52 pp.

2. Bolduc, L. S., and Jolin, M., "Shotcrete Boiled Water Absorption," Shotcrete, V. 12, No. 1, Winter 2010, pp. 12-17.

3. ACI CT-20, ACI Concrete Terminology, American Concrete Institute, Farmington Hills, MI, 2020, 79 pp.

4. Ginouse, N., and Jolin, M., "Material Velocity at the Nozzle," Shotcrete, V. 15, No. 4, Fall 2013, pp. 22-24.

5. ACI Committee 350, "Code Requirements for Environmental Engineer- ing Concrete Structures (ACI 35006) and Commentary," American Concrete Institute, Farmington Hills, MI, 2006, 487 pp.

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7. "Shotcrete for the Craftsman CCS-4(20)" American Concrete Institute, Farmington Hills, MI, 2020, 92 pp.

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Lake of the Ozarks: A Midwest Destination

By Ryan Casserly

The Lake of the Ozarks is a manmade reservoir constructed in 1931 and nestled within central Missouri. This Midwest treasure stretches 92 mi (148 km) from one end to the other, contains a water surface of 54,000 acres and features a shoreline of more than 1,150 mi (1850 km) – that's more shoreline than the state of California. The Lake draws in more than 5 million visitors every year with attractions ranging from fishing, dining, boating, and golfing. The Lake has gained notoriety by way of media coverage featuring Party Cove, The Netflix series 'Ozark,' and most recently social distancing violations during Memorial Day pool festivities in May 2020. The emergence of a trend of visitors seeking a destination aquatic experience in the form of restaurant swimming pools is driving demand for commercial swimming pools designed and constructed to withstand high bather load conditions. This destination experience is where the Westport Pools team enters the conversation providing unique aquatic design and construction delivery.

HIGH TIDE – POOL VENUE: Encore to Redhead Lakeside Grill and Yacht Club

In 2019, Westport Pools was engaged by Mark Waddington (Owner) and Thomas Construction (General Contractor) to design and build a destination pool for a new concept restaurant (High Tide) which would be in addition to the existing highly successful Redhead Lakeside Grill and Yacht

Club. The vision was to create a pool purposely designed for adults featuring swim up bars, underwater benches and in-water tables. These features would compliment the design of other amenities and ultimately drive a high demand with extreme bather loads. Simply stated, the intention would be to have hundreds of patrons at any given time during the summer enjoying refreshing pool water while sipping their beverages of choice.

DESIGN CRITERIA:
High Bather Load

The vision set by the stakeholders required that our design and engineering team not only develop aesthetic concepts, but also focus on hydraulics and sanitation analysis. While the design appeal was imperative the engineering and water quality were crucial elements that required world-class solutions. From our experience, we do not witness many patrons leaving the pool throughout a day despite the input of beverages consumed during their visit. Our focus was ensuring that the filtration and water turnover was sized to handle this observation and the extreme bather loads both of which can contribute to unsanitary conditions. For instance, many standards require that water turnover in 6 hours or less. In this situation, meeting the standard would not be acceptable and likely result in sanitization issues along with a potential visual disappointment and unsafe condition associated with cloudy water. Keep in mind, these conversations pre-dated COVID-19 by 5 months and now the engineering case for such criteria is even stronger.

CONSTRUCTION APPROACH

With the engineering and design complete our team mobilized construction operations alongside Thomas Construction (General Contractor). The project was located on a hillside requiring significant clearing of trees and vegetation. Due to soil conditions, the building pad preparation consisted of controlled fill and 24 in. (600 mm) of clean aggregate base to ensure proper stability and drainage course. With weather conditions rapidly changing due to a winter schedule, construction on the pool shell consisted of a two-step method with a cast-in-place floor and shotcrete walls.

While differing placement methods were executed, ASA Pool and Recreational Shotcrete Committee Pool Position Statement #5 provided our path to ensure a monolithic vessel with no cold joints. The floor of the pool floor was formed (with a keyway) and #4 (#13M) and #5 (#16M) bars placed at 12 in. (300 mm) spacing each way. The entire outside perimeter of the pool was constructed out-of-the ground and against a cast-in-place retaining wall. This retaining wall was constructed before starting the pool construction and the retaining wall and pool were structurally independent of one another. On the retaining wall side of the pool, a bond-breaker was used to ensure no interaction between the two systems. On the in-ground side, “installed formwork” consisted of rough-sawn lumber and sheets of plywood. This forming method is most common with our projects instead of utilizing an “against soil” approach. While the “installed formwork” creates a larger excavation the benefits are two-fold. First, the formwork provides for a rigid, stable and nonvibrating surface which is optimal for receiving high-velocity shotcrete. Second, installed formwork creates a barrier to ensure that plumbing is outside of the pool wall to maintain the structural integrity of the pool shell. Adequate reinforcement was place with #4 bars placed at 12 in. spacing each way with particular focus on maintaining a tolerance of 2 in. (50 mm).

Our next step was to secure a weather window which would conform to our defined winter shotcrete operational plan (this is another topic) and allow wet-mix shotcrete placement. Our shotcrete crew was deployed and completion was achieved in two days followed by appropriate water curing. Upon completion of the pool structural elements, and during the curing period, our team proceeded with field piping and mechanical system installation. Our last milestone was to provide the finishes in the form of waterline and nosing tile along with quartz aggregate plaster.

NO PARTY LIKE AN OZARK PARTY

Our experience is that all projects face obstacles and challenges for even the most skilled of engineers and builders. However, a global pandemic was not a foreseen circumstance as we contemplated our design and delivery. We often get questions on why we provide such enhanced systems and building products if they are not required, code driven or produced by others in the market. Our answer is simple – we desire a world-class facility. In this case, our hydraulic design withstood the test of a pandemic and our shotcrete method provided for a timely delivery so that the owner was able to open the destination on-time (when they were of course comfortable with COVID protocols). If you have not been to the Lake of the Ozarks, consider a visit. It may very well be the making for unforgettable memories. Pools and lakes provide endless aquatic entertainment. They can coexist and in many ways complement one another.

J. Ryan Casserly *is President of Westport Pools, Inc. Founded in 1967, Westport Pools, Inc brings more than 54 years of corporate experience in the aquatics industry, including more than 942 years of combined team experience in designing, engineering, constructing and servicing aquatic facilities of all levels of complexity. Westport maintains multiple business platforms: Design, Engineering, Construction and Service which serves a 14-state region. The engineering team is licensed in 33 states and recently secured their first international project. The construction group has completed 460 projects (primarily design-build) totaling $410 million in aquatic value in the past 15 years. Casserly is a Pool & Hot Tub Alliance – Certified Pool Operator Instructor and member of the ASA Pool and Recreational Shotcrete Committee.*

Preparing your Homeowner for their Pool Installation

By Juanjose Armenta-Aguirre

As in many things, communication is key for a successful residential pool build. For many homeowners, this will be their first pool installation and knowing what to expect will go a long way to making this a positive experience for all involved. The pool industry is currently experiencing never before seen demand and at the same time, supply shortages from manpower to material. The average shotcrete contractor juggles a backlog of jobs, material and parts shortages, and weather constraints which all contribute to a long line of homeowners waiting for their pools. But how many know what to expect when it's their turn?

Here's a typical conversation the day before a dry-mix shotcrete (gunite) pool shoot...

> Pool builder phone rings, shotcrete contractor says, "Hey there, we good for the shoot tomorrow?"
>
> Pool Builder, "Yup, about time! See you tomorrow! First or second shoot?" "First," you say, "See you in the morning!"
>
> Then the homeowner phone rings, pool builder says, "Good day! We just got the confirmation call we have been waiting for. We are going to shoot your pool tomorrow!" Homeowner says, "Wow, that's great! We can't wait! We'll see everyone tomorrow!"

As the homeowner hangs up the phone, a rush of excitement overwhelms them. They get to finally see the shiny rebar and naked, raw cut ground come to life with shape and form. But there also comes a sense of the unknown. What will really happen tomorrow? What do they need to be ready for? This is a normal feeling, no need to stress. However, there are some things you as the homeowner (or project manager, etc.) and your neighbors need to be ready for (yes, I said neighbors if you have them).

Preparación del propietario de su casa para la instalación de su piscina

Por Juanjose Armenta-Aguirre

Como en muchas cosas, la comunicación es clave para una construcción de piscina residencial exitosa. Para muchos dueños de una casa, ésta será su primera instalación de la piscina y saber qué esperar irá una manera larga a hacer esto una experiencia positiva para todos implicados. La industria de la piscina está experimentando actualmente demanda nunca vista y al mismo tiempo, escasez de la oferta de mano de obra a material. El contratista de escopeta promedio hace malabarismos con una acumulación de trabajos, escasez de materiales y piezas, y restricciones climáticas que todos contribuyen a una larga línea de propietarios esperando sus pools. Pero, ¿cuántos saben qué esperar cuando les va a dar el turno?

He aquí una conversación típica el día anterior a una sesión de billar de mezcla seca (gunita)...

> El constructor de piscinas suena, dice el contratista de escopetas, "¿Hay, somos buenos para la toma de mañana?"
>
> Pool Builder, "Ya, ¡acerca del tiempo! Hasta mañana. ¿Primer o segundo disparo?" "Primero," usted dice, "¡Nos vemos por la mañana!"
>
> Entonces suena el teléfono del dueño de la casa, el constructor de la piscina dice, "buen día! Acabamos de recibir la llamada de confirmación que hemos estado esperando. ¡Vamos a disparar su piscina mañana!"
> El dueño de la casa dice, "Wow, ¡eso es genial! ¡No podemos esperar! ¡Vamos a todos mañana!"

Mientras el dueño de casa cuelga el teléfono, una prisa de excitación los abruma. Ellos llegan finalmente a ver el brillante rebar y desnudo, crudo corte tierra cobran vida con forma y forma. Pero también viene un sentido de lo desconocido. ¿Qué sucederá realmente mañana? ¿Para qué necesitan estar preparados? Esta es una sensación normal, sin necesidad de estrés. Sin embargo, hay algunas cosas que usted como propietario (o gerente de proyecto, etc.) y sus vecinos necesitan estar preparados para (sí, dije vecinos si los tiene).

I am not a pool builder. I have been involved in the dry-mix shotcrete world professionally since 1999, and my dad has been involved since the late 1970's both in California and Texas. My Dad even built us a pool in the 1990's and I can remember that day as if it were yesterday (not to be confused with the pool we actually shot yesterday). Here's a dry-mix shotcreter's perspective on what you need to know the day of, and sometime after, the pool is shot (hopefully this is not new information because I hope your pool builder has briefed you on what to expect).

Before the shotcrete crew arrives, we send someone out to do a site check, generally right before the start date. Why is this important? Well for a number of reasons… from verifying the location, to scouting out staging and access issues, and inspecting the reinforcing and formwork layout. Knowing what to expect before you get there, allows you to come prepared.

Location - Here in Central Texas there are new subdivisions being built left and right. We don't always know if we are going to a new subdivision, a remodel, or a new build in an established neighborhood. Sometimes we go to places that aren't on a map or a GPS system. We feel it is easier for one person and one truck to spend the time and energy verifying the location before sending a crew of 10 people with a fleet of 5 or more trucks. This avoids waiting for stragglers who got lost and starting late (we usually try to start at around 7 AM or earlier if allowed).

Confirm availability and use of property resources - When we do our site inspection, we need to verify the resources available to us on site. Especially since dry-mix shotcrete relies on the addition of high pressure water at the nozzle to hydrate the concrete materials, we check the water pressure of the water source we will be using. Whether it's a residence, water well or some other way we are getting the water on site, adequate availability, flow rate and pressure is vital. This isn't as important for wet-mix shotcrete that uses ready-mix concrete, but they still need water to clean and wash out. We also check for electricity. We need to confirm whether adequate power is available, and if not then know we need to bring a generator. Power is especially important if an electric booster pump was required for water pressure, or any electrical tools were needed. With the evolution of cordless tools and much improved batteries on-site power is becoming less of a need.

Accessibility - We check for ingress and egress. How is the access? Where are we going to park the air compressor truck, place the gun (or pump for wet-mix), and park the mixer? Will there be room on the street, or will we need to use the driveway? Can we get onto the property and park close by, maybe behind the project area? Is the ground too soft to drive on because of soil conditions or rain? If it did rain, is the pool excavation full of water and it did have side slopes caved in? If it is flooded, who will pump out the water, clean out the residue, and prepare it for shotcrete placement? Is it on a hill or located far from the equipment staging area? This is important because we need to know how many feet of hose will be needed and if a larger capacity air compressor is required.

Communication - This is also when we talk to the homeowner to confirm what we are permitted to do or not do, use or not use on their property. We verify what, if any, restrictions the Homeowners Association or similar group might have on our work. If we park in the street, for example, are we going to block any driveways? How will the neighbors react to our equipment placement (trust me, we have enough stories about that to write a coffee table book)? We try to communicate to the homeowners that they should park their vehicles far enough from their house so that they have access to the vehicles while we are on the project and to tell all their direct neighbors to do the same, especially if we are going to block driveways or other access points. Since we attempt to start as early as possible (usually at 7 AM or earlier), it is important for the homeowner and their neighbors to expect we will have very loud, very large equipment making lots of noise that early in the morning. I can't tell you how many times we have caught people off guard and unprepared because this was not communicated, resulting in irritation, frustration, and embarrassment. I can't tell you how many times we have had the police called, people threating us with guns and other weapons because

No soy constructor de piscinas. He estado involucrado en el mundo de la mezcla seca y discreta profesionalmente desde 1999, y mi padre ha estado involucrado desde finales de los años 70 tanto en California como en Texas. Mi padre incluso nos construyó una piscina en los años 1990 y puedo recordar ese día como si fuera ayer (para no ser confundida con la piscina que realmente tiramos ayer). He aquí la perspectiva de una escopeta de mezcla seca sobre lo que necesitas saber el día de, y en algún momento después, la piscina es rodada (espero que esta no sea información nueva porque espero que el constructor de la piscina te haya informado sobre lo que puedes esperar).

Antes de que llegue el equipo de la escopeta, enviamos a alguien a hacer un cheque del sitio, generalmente justo antes de la fecha de comienzo. ¿Por qué es esto importante? Bueno, por varias razones… desde la verificación de la ubicación, hasta el reconocimiento de los problemas de almacenamiento provisional y acceso, y la inspección del diseño de refuerzo y formwork. Saber qué esperar antes de llegar allí, le permite venir preparado.

Ubicación - Aquí en el centro de Texas hay nuevas subdivisiones que se están construyendo a la izquierda y a la derecha. No siempre sabemos si vamos a una nueva subdivisión, a una remodelación o a una nueva construcción en un vecindario establecido. A veces vamos a lugares que no están en un mapa o en un sistema GPS. Creemos que es más fácil para una persona y un camión pasar el tiempo y la energía verificando la ubicación antes de enviar una tripulación de diez personas con una flota de 5 o más camiones. Esto evita esperar a los estranguladores que se perdieron y comenzaron tarde (normalmente tratamos de empezar alrededor de las 7 AM o antes si se permite).

Confirmar la disponibilidad y el uso de los recursos de la propiedad - Cuando hacemos nuestra inspección del sitio, necesitamos verificar los recursos disponibles para nosotros en el sitio. Especialmente puesto que el hormigón de mezcla seca se basa en la adición de agua a alta presión en la boquilla para hidratar los materiales de concreto, comprobamos la presión de agua de la fuente de agua que vamos a utilizar. Ya sea una residencia, un pozo de agua o de alguna otra manera que estamos consiguiendo el agua en el sitio, la disponibilidad adecuada, la velocidad de flujo y la presión es vital. Esto no es tan importante para el hormigón de mezcla húmeda que utiliza concreto premezclado, pero todavía necesitan agua para limpiar y lavar. También comprobamos la electricidad. Tenemos que confirmar si hay suficiente energía disponible, y si no sabemos que necesitamos traer un generador. La alimentación es especialmente importante si se requiere una bomba de refuerzo eléctrica para la presión del agua o si se necesitan herramientas eléctricas. Con la evolución de las herramientas inalámbricas y las baterías mejoradas, la potencia in situ se está convirtiendo en una necesidad cada vez menor.

Accesibilidad - Comprobamos la entrada y salida. ¿Cómo es el acceso? ¿Dónde vamos a estacionar la carretilla del compresor de aire, colocar la pistola (o bomba para mezcla húmeda) y estacionar la mezcladora? ¿Habrá espacio en la calle, o necesitaremos usar la entrada? ¿Podemos llegar a la propiedad y al parque cerca, quizás detrás del área del proyecto? ¿Es el suelo demasiado blando para conducir debido a las condiciones del suelo o a la lluvia? Si llovió, ¿está la excavación de la piscina llena de agua y las pendientes laterales se derrumbaron? Si se inunda, ¿quién bombeará el agua, limpiará el residuo y lo preparará para la colocación de excretas? ¿Está en una colina o ubicado lejos del área de preparación del equipo? Esto es importante porque necesitamos saber cuántos pies de manguera se necesitarán y si se requiere un compresor de aire de mayor capacidad.

Comunicación - Esto es también cuando hablamos con el dueño de casa para confirmar lo que se nos permite hacer o no hacer, utilizar o no utilizar en su propiedad. Verificamos qué, si hay alguna, restricciones podría tener la Asociación de Propietarios de Vivienda o grupo similar en nuestro trabajo. Si aparcamos en la calle, por ejemplo, ¿vamos a bloquear alguna entrada? ¿Cómo reaccionarán los vecinos a la colocación de nuestro equipo (confía en mí, tenemos suficientes historias sobre eso para escribir un libro de mesa de café)? Tratamos de comunicar a los propietarios que deben aparcar sus vehículos lo suficientemente lejos de su casa para que tengan acceso a los vehículos mientras estamos en el proyecto y para decirle a todos sus vecinos directos que hagan lo mismo, especialmente si vamos a bloquear caminos de entrada u otros puntos de acceso. Como intentamos empezar tan pronto como sea posible (normalmente a las 7 AM o antes), es importante que el propietario y sus vecinos esperen que tengamos un equipo muy ruidoso y muy grande haciendo mucho ruido temprano por la mañana. No puedo decirle cuántas veces hemos cogido a la gente de guardia y despreparada porque esto no se comunicó, lo que resultó en irritación, frustración y vergüenza. No puedo decirle cuántas veces hemos tenido que llamar a la policía, personas que nos traban con armas y otras armas porque el

the homeowner or pool builder didn't tell the neighbors that we would start work between 6 AM and 7 AM, then waking them up with all the noise we make!

We make sure that the pool plan we have matches what we see on the ground. This includes the reinforcing steel size and layout, formwork and required wall thicknesses. We check for measurements and features. Sometimes things change and it is not communicated to the shotcrete crew. If we are not prepared, it could cause delays the day we are planning to shoot. For example, if the pool is over excavated, if they added or took out a spa, or added a raised beam for a water feature… it affects the amount of concrete and reinforcing needed to accommodate those changes. In most places the pool has to be inspected before shotcrete placement. Did it have the proper inspections, and did it pass the inspection? If not, we can't shoot it. Unfortunately, these small but very important details are not always communicated to the shotcrete company. Thus, it falls on us to ask and verify before getting to the job site.

Dust Protection - Dry-mix shotcrete usually releases some dust at the gun and at the nozzle. When the dust becomes airborne, it can travel quite a distance and settle on adjacent homes, porches, patios, vehicles and outbuildings. Informing the homeowner and neighbors around the project site to move cars and other vehicles so that we can protect the most vulnerable areas will help avoid later repercussions and potentially expensive cleanup. We use tarps to cover areas immediately adjacent to the shoot, in the street, and sometimes even off site areas if instructed to do so by the builder.

Waste Control - Both dry and wet-mix shotcrete produce rebound when being applied. Rebound is primarily coarse aggregate coated with cement paste that bounces off (thus the term "rebound") the receiving surface. Rebound is not proper concrete material and must not be used in any parts of the pool shell. Thus, all rebound needs to be collected and removed from the pool. We need to know where to pile the collected rebound material so that it is easiest for the pool builder to pick up and dispose of it after we leave, and it has dried and stiffened. Likewise, we need to identify a readily accessible location to place all the trimmings and other waste product from the shotcrete placement in the pool, as well as the material cleaned up around the gun or pump to facilitate removal.

After the shotcrete is placed - What happens after the shotcrete crew leaves? The homeowner and builder must have a plan to properly cure and protect the freshly placed concrete. This is vital to provide the strongest most watertight pool shell. Confirm with your pool builder what needs to be done and who will be responsible to do it. ASA's Position Statement on curing ("Curing of Shotcrete for Swimming Pools") can be found on www.Shotcrete.org/Resources, along with several other pool position statements. Proper curing is critical to provide the strongest, most watertight pool shell that will let you enjoy your pool for decades to come with minimum maintenance of the concrete.

A pool built with quality shotcrete placement and careful attention to details can provide homeowners with many decades of wonderful memories, great exercise and enjoyment. Knowing what to expect when your shotcrete contractor arrives will make the experience much more positive for everyone involved.

Juanjose Armenta-Aguirre *- C.O.O., Co-Founder, Texan Concrete Construction Solutions LLC, Texan Gunite*

dueño de una casa o constructor de piscinas no le dijo a los vecinos que comenzaríamos a trabajar entre las 6 AM y las 7 AM, ¡entonces despertándolos con todo el ruido que hacemos!

Confirmar planes - nos aseguramos de que el plan de piscina que tenemos coincide con lo que vemos en el terreno. Esto incluye el tamaño y la disposición del acero de refuerzo, el encofrado y los espesores de pared requeridos. Comprobamos las mediciones y las características. A veces las cosas cambian y no se comunica a la tripulación discreta. Si no estamos preparados, podría causar retrasos el día que planeamos disparar. Por ejemplo, si la piscina está sobre excavada, si agregaron o sacaron un spa, o agregaron una viga elevada para una característica de agua… afecta a la cantidad de concreto y de refuerzo necesario para acomodar esos cambios. En la mayoría de los lugares la piscina tiene que ser inspeccionada antes de la colocación de la escopeta. ¿Tenía las inspecciones adecuadas y pasó la inspección? Si no, no podemos dispararlo. Lamentablemente, estos pequeños pero muy importantes detalles no siempre se comunican a la empresa de hormigón. Por lo tanto, cae en nosotros para pedir y verificar antes de llegar al sitio de trabajo.

Protección contra el polvo - El hormigón de mezcla seca normalmente libera algo de polvo en la mezcladora y en la boquilla. Cuando el polvo llega a ser transportado por el aire, puede viajar bastante lejos y asentarse en casas adyacentes, porches, patios, vehículos y dependencias. Informar al dueño de la casa y a los vecinos alrededor del sitio del proyecto para mover coches y otros vehículos para que podamos proteger las áreas más vulnerables ayudará a evitar repercusiones posteriores y limpieza potencialmente costosa. Utilizamos tarps para cubrir áreas inmediatamente adyacentes al tiro, en la calle, y a veces incluso fuera de las áreas del sitio si el constructor así lo instruye.

Control de residuos - Tanto la mezcla seca como la húmeda de hormigón produce rebote cuando se aplica. El rebote es principalmente agregado grueso recubierto con pasta de cemento que rebota (por lo tanto, el término "rebote") la superficie receptora. El rebote no es un material concreto adecuado y no debe utilizarse en ninguna parte de la valva de la piscina. Por lo tanto, todo rebote necesita ser recogido y removido de la piscina. Necesitamos saber dónde apilar el material de rebote recogido para que sea más fácil para el constructor de piscinas recoger y deshacerse de él después de que nos marchamos, y se ha secado y endurecido. Asimismo, necesitamos identificar un lugar fácilmente accesible para colocar todos los adornos y otros residuos de la colocación de la escopeta en la piscina, así como el material limpiado alrededor de la pistola o bomba para facilitar la extracción.

Después de colocar el excreto - ¿Qué pasa después de que el equipo de escopeta se vaya? El dueño de la casa y el constructor deben tener un plan para curar y proteger correctamente el hormigón recién colocado. Esto es vital para proporcionar la concha más resistente al agua de la piscina. Confirme con su constructor de la piscina qué necesita ser hecho y quién será responsable de hacerlo. La declaración de posición de ASA sobre el curado ("Curación de Shotcrete para piscinas") se puede encontrar en www.Shotcrete.org/Resources, junto con otras declaraciones de posición de piscinas. El curado adecuado es fundamental para proporcionar la cáscara de piscina más fuerte y hermética que le permitirá disfrutar de su piscina durante las próximas décadas con un mantenimiento mínimo del concreto.

Una piscina construida con una ubicación discreta de calidad y atención cuidadosa a los detalles puede proporcionar a los propietarios de viviendas con muchas décadas de maravillosos recuerdos, gran ejercicio y disfrute. Saber qué esperar cuando llegue su contratista de escopeta hará que la experiencia sea mucho más positiva para todos los involucrados.

Juanjose Armenta-Aguirre *- C.O.O., Co-Founder, Texan Concrete Construction Solutions LLC, Texan Gunite*

Benefits of Volumetric Mixers

By Kris Moorman

There are a number of factors that must be addressed when producing concrete. The most important aspects to any project can be grouped into 3 categories:

I. Application – What application will the concrete be needed for?
II. Quantity – How many cubic yards of concrete will be needed?
III. Quality – Are there specifications or mixture designs that must be met?

A volumetric mixer, or mobile concrete mixer as it is sometimes called, is an on-demand concrete production solution. A mobile concrete mixer is a batch plant mounted on a chassis–usually a truck or trailer–and carries unmixed material (sand, cement, coarse aggregates, water and any other materials or admixtures needed for more specialty applications) to a job site and mixes on a continuous or intermittent basis as required for fresh concrete.

Volumetric proportioning is based on volume not weight so through an easy calibration process it is possible to produce concrete that will consistently meet or exceed the tolerances set in ASTM C685 and AASHTO M-241 standards as well as DOT requirements. Mixture designs can be changed or altered without moving the machine. The operator can make adjustments at any time as required for the job site.

In this article we highlight the benefits of using a volumetric mixer over alternative methods of production.

I. APPLICATION

Volumetric Mixer Manufacturers Bureau (VMMB) Certified volumetric mixers are designed to give customers more control over their concrete. As opposed to rotary drum mixers, mobile volumetric concrete mixers allow for an efficient and more environmentally friendly method of producing and casting concrete. Volumetric mixers produce the exact amount and slump of concrete needed at the precise time, eliminating scenarios of under or over-ordering concrete that will ultimately be wasted. As a result of mixing on-site, volumetric mixers require less water, generate less waste and consume less fossil fuels lowering our carbon foot print.

These mixers have been used for a wide range of applications over the past 50 years. Any amount of concrete can be produced from 1 to 400 yds^3 (0.75 to 300 m^3) or greater per day for continuous pouring as long as the unit is re-loaded with the concrete materials at the job site. Due to material being stored in separate compartments, a single volumetric mixer can change mixture designs on the fly without ever returning to a batch plant or dumping unused material. An operator could easily pour 5,000 psi (34 MPa) concrete, select a different mixture design through the control panel and a few seconds later pour a low strength flowable fill.

APPLICATION LIST:

- Infrastructure, municipality, precast, remote jobsites, dry or wet-mix shotcrete, military, utility, mining, airports, bridge decks, foundations, pervious, soil stabilization, pools and watershapes
- Fast setting applications – when time is critical to reopen roads, bridges or airport runways volumetric mixers are the only type that work with fast or rapid setting cements.

II. QUANTITY

Compared to traditional drum mixing, mobile volumetric mixing offers the construction world complete control of their concrete. Volumetric mixers are mounted on trucks or trailers and contain all the necessary ingredients to produce and deliver fresh concrete. These concrete mixers are called volumetric mixers due to their ability to measure raw materials using volume rather than weight. There is not a minimum amount that needs to be produced. Ingredients are mixed on site and only to the specific amount that's required. Material can be delivered to different locations, on one trip from the plant, each which may only require one, two or less than a cubic yard of concrete. If needed volumetric mixers can carry up to 12 yd^3 (9 m^3) of capacity; however, if material is stockpiled, the unit can be reloaded continuously on the

site, extending the amount of concrete produced to whatever amount is needed. A volumetric mixer is a very flexible method for handling construction projects. With material ingredients stored in separate containers and bins, project delays can be easily managed with no waste, overmixed or hot loads.

III. QUALITY

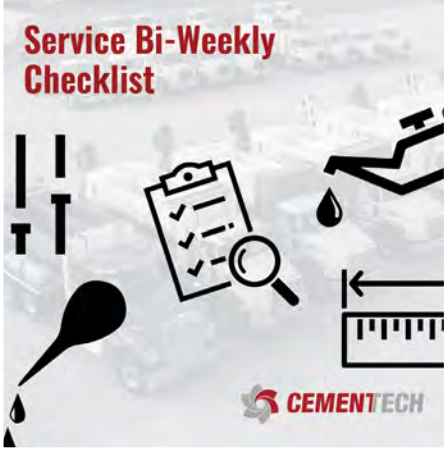
VMMB Certified volumetric mixers meet all the requirements for certification as detailed in ASTM C685, AASHTO 241M and the VMMB standards. These documents were written and adopted to ensure that concrete produced in a volumetric mixer is of the same quality as produced in a certified ready-mix plant. The material produced by either a plant or a volumetric mixer must meet the same tolerances and pass the same tests. The VMMB, was originally organized in November, 1999 with the assistance of the National Ready Mixed Concrete Association (NRMCA). The VMMB was founded for several reasons:

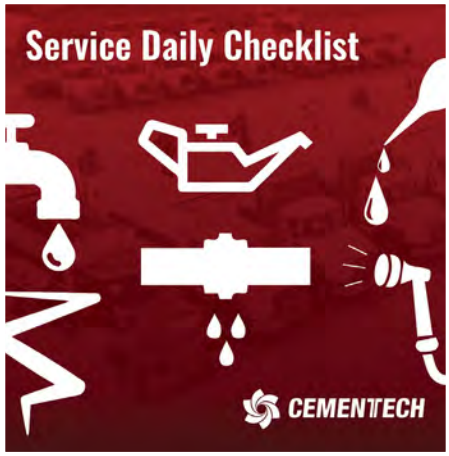
1. to develop, in conjunction with ASTM and ACI, a standard for which this equipment can be rated;
2. to promote the use of this equipment through education and awareness; and
3. to improve the professionalism of both the manufacturers and operators of mobile mixers.

In February of 2001 the first edition of VMMB 100-01, the Volumetric Mixer Standards were published. As with the other Bureaus, only units that are built to these Standards, and pass all the required tests, are eligible to receive and display the VMMB registered rating plate. Each of these is numbered, and cannot be transferred to another unit.

This unique plate is a guarantee that the unit it represents met all of the requirements for capacity, accuracy, and consistency that have been established for the industry at the time of manufacture.

Concrete produced at a batch plant must be transported to the job site, which is the reason for time restrictions that are written in documents such as ASTM C94 regarding material acceptance that is more than 90 minutes old, or has been subjected to a specified number of drum revolutions. The hydration process begins once water contacts cement, and continues until the available water is gone. Additionally, as material tumbles in a drum, it undergoes a forming and breaking of bonds between aggregate particles. This process degrades the final material and generates heat, ultimately reducing the final strength of the concrete. A volumetric mixer offers a substantial time advantage. With the concrete being produced as needed, fresh, on site, there is no time restriction or loss of strength due to extended mix times.





The Terracon Report, Volumetric versus Drum Truck, Revision 1 – Volumetric Mixer Manufacturing Bureau (VMMB) Project No. 92101448 demonstrates that concrete produced from a volumetric mixer is higher in compressive strength as a result of avoiding drum mixer fatigue.

The most important factor of concrete quality is the water to cementitious ratio (w/cm). These two ingredients, water and cement, are responsible for binding everything together. The w/cm largely determines the strength, durability, workability and finishing quality of the concrete. Many specifications consider this ratio the foundation for building and approving concrete mixture designs. The more water added, the more the strength of the resulting concrete is reduced. When using too little water, the the concrete will be more difficult to place and finish. The difference between too little and too much water can be 1 gal/yd^3 (5b l/m^3). Adding 1 gal of water to a cubic yard of a given mixture design will lower the final strength 200 – 300 (1.3 – 2 MPa), and increase the slump of the material 1 in. (25 mm). Simply put, adding 1 gal of water to a cubic yard of a given mixture design will effectively eliminate the impact on strength of 25 lb (11 kg) of the cementitious material. This is the reason ASTM C94 and other related specifications call for restrictions on the addition of water to a mixture, once it has been batched.

A volumetric mixer allows the operator to control the precise amount of water being added to any mixture. Because the concrete mix we are producing is fresh, typically 10-15 seconds old before it hits the delivery system, there is no need to add water above the designed amount. We are not impacted by slump loss or hot loads that require additional water.

Kris Moorman *joined Cemen Tech in June 2016 and brings experience in brand development, analytics, digital strategies, communications and business development to the team. A Simpson College graduate with various post graduate marketing & communications work, she also has extensive B2B sustainability experience in green building, energy and water consulting with organizations ranging from Fortune 500 to start up.*

GUNNITE International (Pty)Ltd

MANUFACTURERS & SUPPLIERS OF GUNNITE & MINING EQUIPMENT & CONTRACTORS.

SPRAYED CONCRETE EXPERTS

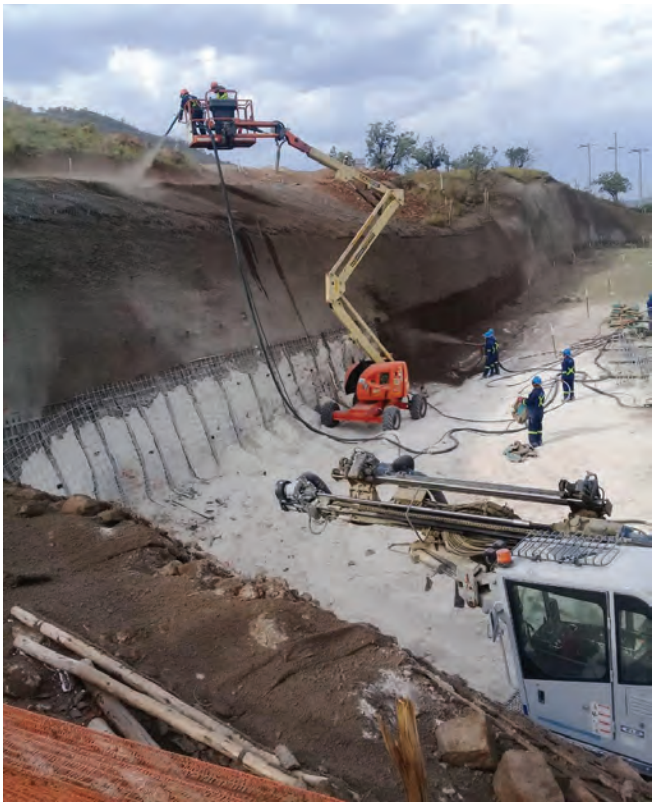
Gunnite International is a manufacturing and geotechnical contracting company founded in 1992 by Wayne Treges who has over forty years' experience in the shotcrete Industry.

From the inception of the company, we have been a preferred supplier to a host of mines in and around South Africa and internationally. We manufacture and distribute a top-of-the-line product that provides value and great service to our customers.

Over the past twenty-nine years Gunnite International, a O.E.M. company, has gained extensive experience in geotechnical shotcrete work and has established itself as a high-performing and reputable firm not only in South Africa but internationally too.

MISSION

We want to be the organization that outperforms and over-delivers for our clients. We also want our clients to keep us front of mind when they consider a quality product for their projects. Being members of the American Shotcrete Association (ASA), we make it our mission to keep up to date with all the training techniques and latest cutting-edge technologies that are available.



VISION

To continue to offer our professional insights and experience as a sprayed concrete supplier and contractor to leading organizations.

Our ROCKMAX 90, ROCKMAX 60, MINI-MAX and MICRO-MAX are the leading dry-mix shotcrete machines in the mining, construction and refractory industries in South Africa and neighbouring countries. We are constantly improving on the quality, operation, and excellence of the equipment.

Our Rockmax 90, Rockmax 60 and Mini-max are designed exclusively for transporting any form of dry-mix shotcrete material. The machines require little maintenance and are simple to operate.

GUNNITE INTERNATIONAL'S MACHINES ARE USED FOR THE FOLLOWING SHOTCRETE APPLICATIONS:

- Concrete Repair and Restoration
- Embankments
- Retaining Walls
- Lateral Support
- Security & High Walls
- Low-Cost Housing
- Dams, Ponds and Swimming Pools
- Reservoirs
- Channels
- Bridge Repairs
- Fire Resistant Concrete
- Basement Support
- Domes & Arches
- Skate Parks
- Mining Shafts & Tunnel Support
- Pilling Support
- Silo Lining
- Slope & Ground Stabilisation
- Refractory Lining

Gunnite International's Machine Specifications range from production rates of 1.4 to 1.8 m^3/hr (1.8 to 2.4 ft^3/hr) with equipment weights from 520 to 600 kg (1150 to 1300 lbs).

GUNNITE INTERNATIONAL (PTY) LTD

For more information about our company consult our website at www.gunnite.co.za. Our contact details are:

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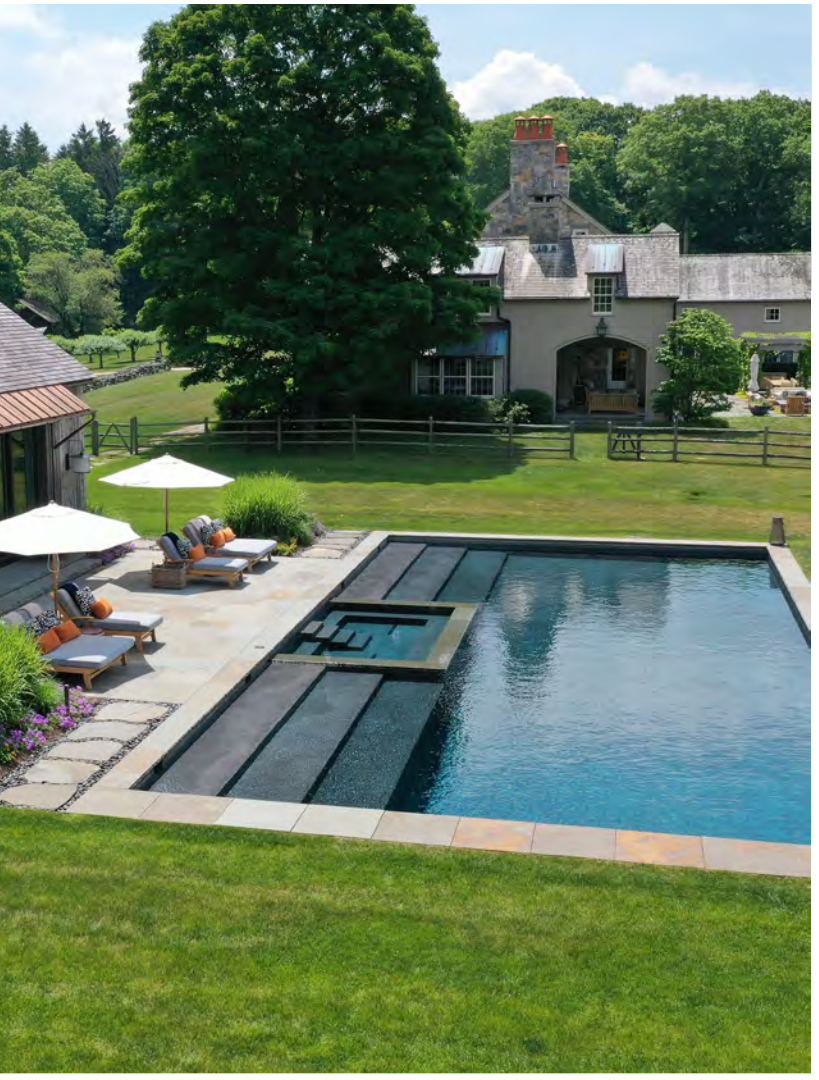
Watershape University

DEFINING AQUATIC EXCELLENCE AT EVERY TURN

Watershape University (WU) is a leading provider of quality instruction -- live and online -- targeting the business of watershaping with design, engineering, and construction programs for students of all levels in the pool, spa, aquatics, and outdoor living sectors. WU supports and promotes the use of recreational and decorative water through accredited education and fosters a greater understanding of the benefits and value of aquatic activities and lifestyle.

Although founded in August 2019 by David J. Peterson and William T. Drakeley, WU is defined by decades of teaching and professional practice among staff, faculty, and volunteers engaged in its educational and credentialing programs. WU encourages personal development through membership in the elite International Watershape Institute (IWI), providing principled leadership, a supportive culture and altruism to benefit the industry and society.



Our multi-pronged approach includes third-party accredited education designed to provide a credentialed path for career advancement through WU; financial support from manufacturers/suppliers through corporate engagement; coaching and outreach through the IWI.

WU acquired WaterShapes.com (formerly *WaterShapes Magazine*) in Spring 2020 as a trusted, digital resource for the industry, professional community, and consumers of all things aquatic. WU has also established on ongoing strategic alliance with Wallace "J" Nichols, author of the best-selling book "Blue Mind." With J, WU established the Live Blue Foundation, a non-profit organization devoted to "getting people near, in, on and under water – for life."

We believe that principled leadership, honesty and integrity, a supportive culture, and altruism will result in personal growth and professional gain for the entire industry and consuming public. We mean to see pools and other types of watershapes recognized as the gateway to the world of water, and WU considered the

WHAT IS THE WOLFPACK?

The Wolfpack is the official mascot of Watershape University because the pack is extremely social, intelligent and curious, with excellent communication skills used to help each other.

What are Wolfpack Webinar Wednesdays? The pack joins every Wednesday at noon Pacific time for one hour of education and training about a variety of watershaping subjects from design, engineering, and construction to service, operations, and products from our Corporate Engagement team. Most of these webinars are free but some are paid.

leading educational authority on how best to design, build, service and sell manmade bodies of water.

The work we do at WU has widespread benefits. Our constituents include: our credentialed students; their companies, employees and subcontractors; our faculty and coaches; corporations engaged as WU associates, colleagues and partners; the entire professional watershapes community; consumers, and all of humankind.

WU is founded on the premise that an educated "team" of professionals is the best setting for collective and individual success. To borrow an iconic phrase "of the people, by the people, for the people" – that is WU. We are an ever-growing, and evergreen TEAM of individuals and companies working together to ensure the long-term prosperity of the aquatics industry through an educated workforce and an educated world on the benefits of an aquatic lifestyle.

Principled universities long survive their founders. That is the expectation with WU – a living and breathing entity that will thrive long into the future, based on values and principles that have always and will forever endure.

WU is devoted to promulgating the highest possible standards for design, engineering and construction, including those maintained and promoted by ASA for proper and reliable mixing and placement of shotcrete.

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SHOTCRETE CALENDAR

Please check with the meeting provider as some meetings may be postponed or cancelled after publication of this issue of Shotcrete.

NOVEMBER 16 – 18, 2021	**International Pool | Spa | Patio Expo** Kay Bailey Hutchison Convention Center | Dallas, TX **www.poolspapatio.com**
NOVEMBER 16, 2021	**ASA Shotcrete Nozzleman Education @ PSP 2021** Kay Bailey Hutchison Convention Center | Dallas, TX Required for New & Nozzlemen-in-Training pursuing ACI Certification **www.shotcrete.org/Events**
NOVEMBER 17, 2021	**Recognizing Quality Shotcrete @ PSP 2021** Kay Bailey Hutchison Convention Center | Dallas, TX **www.shotcrete.org/Events**
NOVEMBER 18, 2021	**PHTA/Genesis Education Session C225: Quality Shotcrete Placement for Pool Contractors** Kay Bailey Hutchison Convention Center | Dallas, TX **7:30 AM – 9:00 AM** **www.shotcrete.org/Events**
JANUARY 18 – 20, 2022	**World of Concrete 2022** Las Vegas Convention Center | Las Vegas, NV **www.worldofconcrete.com**
JANUARY 19 – 22, 2022	**Southwest Pool & Spa Show 2022** Henry B. Gonzalez Convention Center | San Antonio, TX **www.swpsshow.com**
JANUARY 25 – 27, 2022	**2022 Pool & Spa Show in Atlantic City** Atlantic City Convention Center | Atlantic City, NJ **Thepoolspashow.com**
FEBRUARY 17-18, 2022	**Canadian Concrete Expo** The International Centre, Toronto, Canada **www.canadianconcreteexpo.com**
FEBRUARY 26, 2022	**ASA Shotcrete Contractor Education** **Sonesta Resort | Hilton Head, SC** **8:00 AM – 3:30 PM**
FEBRUARY 27 – MARCH 1, 2022	**2022 ASA Shotcrete Convention & Technology Conference** Sonesta Resort | Hilton Head, SC **www.shotcrete.org**
MARCH 2 - 3, 2022	**New York Build Expo** HALL 3A, Javits Center | New York, NY
MARCH 31, 2022 - APRIL 1, 2022	**Chicago Build Expo** **McCormick Place | Chicago, IL**
JUNE 17 - 24, 2022	**North American Tunneling Conference (NAT) 2022** Philadelphia, PA **www.natconference.com**
MORE INFORMATION	To see a full list, current updates, and active links to each event, visit www.shotcrete.org/calendar.

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AMERICAN CONCRETE PUMPING ASSOCIATION (ACPA) RELEASES NEW SAFETY MATERIALS

The American Concrete Pumping Association (ACPA) has released new and updated safety materials to fulfill its ongoing mission of promoting safe concrete pumping practices. The first item, Safety Bulletin: Use of Lay Flat Hose, identifies and illustrates the handling guidelines for using lay-flat hoses on the job.

Lay-flat hoses allow for improved flow control and lower placement rates than standard concrete boom tip hoses and are a popular accessory when pumping is required in tight spaces such as ICF forms, columns, and walls.

"It is important for concrete pumpers and concrete contractors to understand the differences between lay-flat and standard boom tip hose applications," says Executive Director Christi Collins. "Although similar, each have specific guidelines that should be followed for their respective uses. This new safety bulletin responds to a need in the industry for increased education when using lay-flat hoses to avoid certain hazards, such as kinking, which can cause a hose whipping. Hose whippings are a leading cause of accidents with a concrete pump."

The new safety bulletin complements the Association's extensive safety library and is available for download on the Association's website Safety/Training page: www.concretepumpers.com/content/safety-bulletin-use-lay-flat-hose

Next, the ACPA updated two of its Safety Guidelines for Wind Velocity and Lightning. These guidelines outline the ACPA's recommended practices in severe-weather events and more.

Wind Velocity reflects changes to previous generic guidelines and defers more specifically to the pump's manufacturer; Lightning expands on the definition of determining when to stop pumping operations when lightning is present and when it's safe to re-start.

The Safety Bulletin: Use of Lay Flat Hose and Safety Guidelines for Wind Velocity and Lightning, are available for download on the Association website at www.concretepumpers.com/content/contractors.

Continually updating safety resources is part of ACPA's mission to foster and promote a positive safety culture within the concrete pumping industry. For additional resources on general safety, visit the ACPA's Safety/Training page, where safety materials are easy to find, and many are available for download at no cost. In addition, the ACPA's online catalog, www.concretepumpers.com/catalog, has materials available for purchase.

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GENESIS® LAUNCHES NEW BRAND AND CAREER PATHWAYS

GENESIS®, a company of the Pool & Hot Tub Alliance (PHTA), is pleased to present its new brand, complete with a new website, logo, digital badges, and educational pathways.

Since 1998, GENESIS® has taught thousands of students in best practices governing proper water vessel design, engineering, and construction. As the world has evolved over the last year and a half, GENESIS® has evolved with it. When in-person classes were no longer an option, GENESIS® quickly pivoted to live, virtual classes and added on-demand course offerings to the PHTA website.

GENESIS® offers the most comprehensive and complete education in our industry and the new website features the available business, construction, design, and business courses that pool professionals can take to develop their skills and knowledge.

"Across the board, students who have taken GENESIS® courses have learned new design strategies, color theories, engineering best practices, solid construction, and so much more," said PHTA President and CEO Sabeena Hickman, CAE. "And, because the world has changed, so have we. The PHTA Certified Pool Builder and Design Professional Pathway was created to build upon this foundation of knowledge and set the standard of excellence for professional pool builders. We are excited about the opportunities for advancement through the pathways with CBP being the nucleus for professional pool builders."

To learn more about GENESIS®, visit genesis.phta.org. For more information, please contact Janay Rickwalder, PHTA's Vice President of Marketing and Communications, at jrickwalder@phta.org or 703.357.3918.

FREE CONCRETE REPAIR EDUCATIONAL SERIES

The need for awareness and education about concrete maintenance, preservation, and repair has never been greater. As a public service, the International Concrete Repair Institute (ICRI) is pleased to offer free concrete repair educational resources. Five on-demand technical presentations and webinars have been released. The repair educational series topics include:

Series 1: Evaluation & Assessment (Part 1)
Series 2: Evaluation & Assessment (Part 2)
Series 3: Repair
Series 4: Strengthening, Corrosion Protection, Protective Systems and Maintenance
Series 5: ACI 562 Repair Code and Guide

ICRI is uniquely able to provide its collective knowledge of concrete, what causes its deterioration, and how to extend its service life through regular maintenance and repair.

Once registered, you will be able to access these technical presentations and webinars in the ICRI Learning Center at no charge for a period of 6 months.

Registration for the free resources is available through December 31, 2021.

Access to the series is at store.icri.org/tag/repair. For comments or questions, please contact info@icri.org.

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SHOTCRETE CONVENTION & TECHNOLOGY CONFERENCE

Plan to attend this unique event designed for the shotcrete community. Join other leaders in this field to learn, network, and share knowledge over the technical sessions, committee meetings, exhibits, social activities, and meals! And don't forget to purchase your ticket to the 17th Annual Outstanding Shotcrete Project Award winners' banquet, which will be celebrated at this event. Visit www.shotcrete.org to register today!

ASA 17TH ANNUAL OUTSTANDING SHOTCRETE PROJECT AWARDS BANQUET

The ASA Outstanding Shotcrete Project Awards banquet will be held face-to-face during our 2022 Shotcrete Convention & Technology Conference, Tuesday, March 1, 2022. The Outstanding Shotcrete Project Awards program recognizes excellence and innovation in projects where shotcrete placement played a significant role. Our awards program strives to recognize and celebrate all the various markets where shotcrete placement has proven to be a practical, creative and cost-effective method for constructing or repairing with strong, durable concrete.

Awards will be given in the following six categories:

- Architecture | New Construction
- Infrastructure
- International Projects
- Pool & Recreational
- Rehabilitation & Repair
- Underground

Visit www.shotcrete.org/ASAOutstandingProjects to purchase your tickets and view the virtual 16th Annual Awards Celebration.

ADVERTISE IN SHOTCRETE MAGAZINE

Grow your business by investing your marketing dollars through advertising in ASA's Shotcrete magazine. Shotcrete magazine is the only international magazine focused exclusively on the shotcrete industry. Our magazine covers all aspects of the shotcrete market and highlights our shotcrete advances and achievements—from recognizing outstanding projects, to reports on shotcrete research, to articles exemplifying the state-of-the-art of shotcrete placement. Each issue of Shotcrete magazine has a readership of over 17,000 subscribers in over 100 countries.

Themes for 2022 include:

- Winter –Award Winners
- Spring – Specifications
- Summer – Materials
- Fall – Productivity

Look for the 2022 Shotcrete magazine media kit online at www.shotcrete.org/mediakit. For more information, rates, and deadlines, contact Tosha Holden, ASA Editorial and Marketing Manager, at tosha.holden@shotcrete.org or 248.983.1712.

ASA SHOTCRETE NOZZLEMAN EDUCATION COURSES AT POOL | SPA | PATIO EXPO 2021

Kay Bailey Hutchison Convention Center | Dallas, TX

INTERNATIONAL POOL | SPA | PATIO EXPO

SPONSORED BY POOL & HOT TUB ALLIANCE

ASA Shotcrete Nozzleman Education Course, presented by the American Shotcrete Association will be held, November 16 – 18, 2021 at the Kay Bailey Hutchison Convention Center in Dallas, TX. Visit https://www.poolspapatio.com/en/register.html , under Specialty Education then ASA Education, to register for:

- ASA Shotcrete Nozzleman Education
  (Either English or Spanish)
  Tuesday, November 16, 2021
  Fee: $425
  *Course is also available in Spanish.
- Quality Shotcrete – Know It When You See It
  Wednesday, November 17, 2021
  Course with exam: $655
  Course only, no exams: $435
- ACI Shotcrete Nozzleman Certification
  (Wet-Mix & Dry-Mix; Vertical & Overhead)
  Thursday, November 18, 2021
  Cost for New, Nozzlemen-in Training, or Recertifications: $1500 pp (Includes written & performance exams)

Registration and work experience submission deadline – November 8, 2021. Questions about these programs, along with interests in pursuing certification, should be directed to Alice McComas with ASA at 248.983.1702 or email Alice.McComas@shotcrete.org. For additional information about ASA visit www.shotcrete.org.

ASA will also be exhibiting in Booth #1953 – Stop by and visit!

asa

The Art of Shotcrete WINNERS

Congratulations to our **Art of Shotcrete** winners! Thank you all for submitting photos in the 1st Quarter 2021 judging of the Art of Shotcrete.

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SHOTCRETE FAQs

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

Question: *I have used ASA's Position Statements from the Pool and Recreational Committee and find them very useful. Are there any design guides or books on shotcrete pool design that are available? I am a structural engineer and tend to design pools as retaining walls, but I believe some of my designs could be "value engineered" to reduce rebar in the case of walls with a vertical curve (base of the wall is curved and not straight) and possibly the use of a bond beam at the top.*

Answer: The current International Swimming Pool and Spa Code (ISPSC) has no provisions for design of concrete pool shells. Many structural engineers use ACI 350 *Code Requirements for Environmental Engineering Concrete Structures* for pool structures, especially commercial pools. ACI 350 is based on ACI 318 *Building Code Requirements for Structural Concrete* but has modifications to provide a design for concrete structures that are normally exposed to water, and thus need more crack control for watertightness. ACI 350 also addresses requirements for durability for concrete exposed to liquid so that structures will be expected to be serviceable for at least 50 to 100 yrs. Some engineers feel ACI 350 is overkill for pools and may use ACI 318, or just use their past experience. Generally, use of ACI 350 will require a higher percentage of reinforcing steel, have closer steel spacing and somewhat reduced tension in bars to control cracking. ACI 350's concrete cover provisions may also be somewhat higher than ACI 318, to provide more corrosion protection of reinforcing. ACI Committee 506 is developing a guide document for construction of shotcrete pools, but does not directly address design. ACI has recently authorized a new technical committee to develop a Code for Design of Pools and Watershapes. However, staffing the committee and then developing a consensus standardized document will take several years.

Regarding the cove of the floor-wall joint, if you have a cove or the bond beam you can use the additional "d" distance for your vertical steel from external loads on the walls though the moment has to be carried in the thinner sections of the floor and wall adjacent to the cove. If you consider the bond beam is a stiffening element for the top of a straight wall acting as a panel between the ends in a rectangular plan pool you may be able to reduce some of the vertical bending stresses. However, that may be hard to quantify for a freeform pool without a more advanced analysis.

Regarding reference books you may find David Billington's Thin Shell Concrete Shells useful for analysis and design of concrete shells. It is an old book (1982 for 2nd Edition) and may be hard to find but may be helpful. Hopefully ACI's new Code Committee for Pools will set the standard of practice in the pool industry and be specifically referenced by ISPSC.

Question: *What would be the right concrete mixture for a swimming pool? I found out that a few concrete plants have different mixes, so I wanted to know what would be the correct one.*

Answer: There is no special requirement for shotcrete placement in pools. Basically, you are building a watertight structural concrete shell. Concrete should be a minimum 28-day compressive strength of 4000 psi (28 MPa). Most shotcrete uses a 3/8 in. (10 mm) maximum coarse aggregate size due to our small diameter delivery lines. The coarse aggregate (rock) being about half the weight of the sand content. We typically need a cement-rich paste so minimum cementitious content (cement, fly ash, slag) of 700 lb/yd^3. We also need a low w/cm ratio for the ability to stack in the wall so maximum of 0.45, with most wet-mix concrete 0.42 or less. You may find our ASA Position Statements for our Pool and Recreational Committee helpful in providing more detail. Our current statements include:

- Compressive Strength Values of Pool Shotcrete
- Shotcrete Terminology
- Sustainability of Shotcrete in the Pool Industry
- Watertight Shotcrete for Swimming Pools
- Monolithic Shotcrete for Swimming Pools (No Cold Joints)
- Forming and Substrates in Pool Shotcrete
- Curing of Shotcrete for Swimming Pools

You can find the position statements freely available at www.shotcrete.org/products-services-information/resources/.

Question: *A new gunite pool of ours was sprayed in an irregular fashion by a non-certified worker in the Bahamas. For the most part, the pool looks good, but one wall was measured at 3 in. The rest of the pool is 6 in. The rebar in the thin area was encapsulated which was good, but a couple of linear cracks in the wall formed even after ample wetting during the initial cure period. Six months have gone by. Our plan now is to pressure wash the cracked areas and add an additional 6 to 8 in. of gunite thickness which may not look too bad since the pool is a natural lagoon style pool. Staples with gunite over the top would be the other option. What is your opinion?*

Answer: Properly prepared surfaces along with proper shotcrete materials, equipment and placement techniques will produce a construction joint that acts monolithically and not be a "cold" joint. Shotcrete placed onto an existing

concrete surface will provide an excellent bond IF the following conditions are met:

1. Make sure the surface is roughened and clean.
   a. The amplitude the of roughness should be +/- 1/16th in. (1.6 mm) or more.
   b. If the surface was not roughened when it was shot be sure to have the contractor roughen it.
   c. A high-pressure water blaster (5000 psi [34 MPa] or more) or abrasive blasting can help to roughen and clean the surface.
2. Bring the concrete surface to saturated surface dry (SSD) condition. This means the surface feels damp, but water is not picked up on a hand.
3. Make sure the shotcrete placement is properly executed with high velocity placement and quality materials.
   a. The dry-mix shotcrete (Gunite) should have a minimum 28-day compressive strength of 4000 psi (28 MPa).
   b. Be sure the shotcrete contractor is using an air compressor able to produce at least 385 CFM (11 m3/min) of air flow at 120 psi (0.83 MPa).
   c. Use of an ACI-certified shotcrete nozzleman is recommended.
4. No bonding agent should be used. It will interfere with the natural bonding characteristics of shotcrete placement.

This article on the excellent bond between shotcrete provides more detail: https://shotcrete.org/wp-content/uploads/2020/05/2014Spr_TechnicalTip.pdf

The pool wall thickness is a part of the pool engineer's design. Adding 6 to 8 in. to the existing 3 in. (75 mm) would be making the overall thickness 9 to 11 in. (225 to 275 mm). This would require more reinforcing steel, so you should verify with the pool designer the additional reinforcing steel requirements.

You may also find our ASA Position Statements on Pool Construction helpful as a reference for proper pool shotcrete construction. They are freely available at: https://shotcrete.org/products-services-information/resources/

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

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