

Reflecting on a Shotcrete Pool

By Ryan Oakes

Dry-mix shotcrete—also known as gunite—has a bad reputation in some parts of the structural shotcrete industry, as well as in the pool marketplace. There are a multitude of reasons that contribute to this perception, but foremost is the lack of education on the side of the specifiers, the contractors hiring the shotcrete crews, and sometimes even the crews and the company owners. It is amazing that so few people with so many years of experience in their trade don't know why past failures exist in their trade, particularly in shotcrete, both wet and dry.

While this article is not about the industry's shortcomings, it is a relevant preface to why we were called into the project that this article is about. In short, a pool had been shot and failed miserably. While the owners were sorting out the problems with the previous pool builder and the dry-mix shotcrete installer, time passed and the home construction continued. By the time Clearwater Construction Group, Inc., was called in to both finish demolition of the previous work and build the new pool, there was a really nice home on one side and on the other three sides, a 40 ft (12 m) drop to the ground, with a 400 ft (120 m) slope down a mountain thereafter! Minimal access was available on one cliffside so between wheelbarrows through the house and a track loader on the cliff side, over 60 tons (54,000 kg) of remaining demolition materials were hauled away.

A Fresh Start

Subsequently, a clean slate remained: a suspended sub-slab, in excellent condition, cantilevered over 40 ft (12 m) tall concrete walls. The new pool was to be built just as the original had been designed. Because it was being built on the sub-slab, the three vanishing-edge sides of the pool would be fully exposed to the elements and partially exposed to the viewer. The exterior surface is slated to be covered in a stucco product to match the color of the stone on the home and the interior of the pool is completely surfaced in black 0.75 in. (20 mm) glass mosaic tile.

On the side of the pool that touches the decking, a Lautner's edge detail was used to create

the illusion that the water meets the top surface of the adjacent Travertine decking material. This detail involves finishing a delicate knife edge during the shotcrete process that separates the pool water from a hidden gutter, which carries the overflowing water back to the equipment room. In this case, the equipment room is underneath the pool. To install this edge during the shoot, we brought along extra finishers. In fact, we had several extra helpers on this project due to all the detail work required (Fig. 1).

Overall, there were over 90 ft (27 m) of vanishing edge, over 40 ft (12 m) of the Lautner's edge gutter, and a perimeter overflow spa, along with two sets of steps, an underwater bench, and two large shallow-water lounging areas (Fig. 2).

Understanding the technical nature of the pool and the difficult logistics, we planned on this being a multiple-day shoot. Leading up to the shoot, Clearwater Construction Group formed the project with extremely rigid framing so that we not only had a good surface to shoot to but also to walk on and navigate around without fear of falling or damaging formwork. Safety lines were run on the outside of the project so that any finisher who had to step out of the pool could clip in with their safety harness. The reinforcing bar, all No. 4 (No. 13) steel, was well-placed and tied so that it, too, could be walked and climbed on with minimal movement in the steel. There was a great deal of plumbing to shoot around, including a 6 in. (150 mm) trunk line with vertical risers every 5 ft (1.5 m) for the overflow water. The spa plumbing was very intricate and required a great deal of care and skill in placing the shotcrete around the pipe and fittings well. Finally, we were given a 1/32 in. (0.8 mm) tolerance to hold on the vanishing edge to reduce the amount of water needed to flow over the edge (Fig. 3).

A New Perspective

Pools have forever been plagued with efflorescence, water-retention problems, and installation complications. Particularly, vanishing-edge pools with at least one side of the vessel being exposed to the elements and not hidden in earth



Fig. 1: Shooting the negative-edge trough while the finishers quickly work with the silica-fume-enhanced concrete and remove rebound and trimmings from the project



Fig. 2: The finished shell shortly after being shot



Fig. 3: Some of the intricate plumbing and steel work

are prone to efflorescing on the exterior of the shell, which can be quite unsightly and cause problems with the exterior cladding.

In this situation, not only did we need to hold water in but we also needed to shoot walls 26 in. (0.66 m) thick standing 5 ft (1.5 m) high. To mitigate both the efflorescing problem and to aid with the rapid buildout, we proposed to the pool designer, Brian Van Bower with Aquatic Consultants, the use of silica fume as a supplemental cementitious additive in the dry-mix shotcrete material. He agreed and conferred with the Architect, Steven Price, and with Bill Drakeley, who served as our shotcrete inspector on the job. Both agreed with the addition.

Silica fume has long been used in the infrastructure and tunneling industries and has proven to reduce efflorescence, reduce rebound in the shotcrete application, and increase the ability to build out rapidly. Silica fume has also been laboratory-tested and proven to reduce permeability in concrete. The volumetric batch trucks that Revolution Gunite uses are designed to be able to add silica fume as an additive before the mix bowl. After careful calibration of the truck for the correct dosage, we used the silica fume in all parts of the pool except the floor, where we felt it wasn't necessary.

Due to the problems on the previous structure, there was a great deal of scrutiny on the project. We were asked to provide several test panels—one for each day of our shoot to be indicative of the project and material placement. Our test panels proved an added benefit to the structure from the use of the silica fume, which was additional strength. We were already shooting our engineered mixture design that averages over 5000 psi (35 MPa), but these breaks came back as high as 8440 psi (58 MPa). We cured the test panels in the same way we cured the pool, which was through soaker hoses left to flood the structure. Once the pool structure was shot, we flooded it and let it cure for a month. The test panels were pulled out after 7 days and tested at 7, 14, and 28 days. After a month of curing in a flooded state, there were no signs of efflorescing anywhere in the project and no walls showed moisture on the exterior surfaces. We succeeded in providing a watertight, efflorescence-free project with high compressive strengths.

Being a glass tile pool, the glass tile manufacturers have specific requirements for the surface preparation. This pool was sprayed with Aquaron CPSP and was also coated with Flexcrete after all surface preparations and before the tile application.



Fig. 4: Nozzling in good form with a great view

Logistics and the Dry-Mix Process

There was a beautiful home with construction well underway in between the staging area for our batch trucks and the pool. Although the hardwood floors, interior paint, and trim work were all complete in the house, we needed to run our lines through the middle of the house. Overall, we needed approximately 300 ft (90 m) of delivery lines to get our shotcrete to the pool. Using the dry-mix process, our hoses don't surge like a hose from the wet-mix process, so there was less risk of damaging the floors; that said, we still protected the floors with thin plywood and plastic. Also, the dry-mix hoses run much less pressure than a wet-mix pump, so the risk of a hose bursting and spraying the interior ceilings with the shotcrete materials were minimized.

Being such a technical project, we decided to shoot the floor first, followed by the walls and other details on Days 2 and 3. Dry-mix shotcrete was the perfect application method (Fig. 4 and 5). We are able to start and stop as needed to focus on the details and not worry with scheduling concrete trucks because the shotcrete material isn't hydrated until exiting the nozzle. It is mixed with water on demand as needed. To continue over multiple days, our crew members benched

off material at ideal stopping points and maintained clean reinforcing bar through the use of a blow pipe both during the shoot as well as between shoots to aid in cleanup. All surfaces were maintained in a saturated surface-dry (SSD) state while shooting onto previously shot areas. In addition, the crew members are versed in removing laitance from the hardened surface and providing the optimum surface for shooting a subsequent layer the following day. The large volume of air in a dry-mix rig, along with the water at the nozzle, can provide a strong air-water blast that's great for cleanup and also for wetting the surface to provide an SSD condition when not sending material through the lines.

The downside of the dry-mix method is that more care is needed in material handling. With wet-mix shotcrete, it doesn't matter if the aggregate is wet before it is mixed because water is being added to the mixture anyway. With the dry-mix method, too much moisture in the sand can be problematic or even shut down the job. In our case, we typically stockpile large quantities of dry sand (3 to 5% moisture content) at our yard and reload at our own facility or a satellite yard. On this job, being in a remote location in the mountains of North Carolina, that was not an



Fig. 5: The use of a blow wand, seen in the hands of the gentleman with the red shirt, is critical to maintaining quality throughout the project

option, so we stored 125 tons (113,000 kg) of sand nearby with a loader, where we kept the material dry until it was needed. We had a relationship with a local ready mix provider who supplied us with our cement reloads (conveniently located near our sand pile). Our material reloads were nearby, so we only needed two batch trucks traveling back and forth for the job.

The jobsite was extremely congested, so we coordinated with the general contractor on the job to minimize other sub-trades during our shoot, so that we had room for our compressor truck and the material batch trucks. We exercised a great deal of control over our aggregate (sand) pile. To start, we used sand from the same pit that our mixture design was based on so that variations in aggregate were minimal. Then we placed the large pile of sand on a concrete slab so that soil contamination was not an issue. Finally, we covered the pile to prevent moisture gain from the daily mountain rains, as well as preventing windborne contaminants, such as leaves, from entering the pile.

One of the benefits the crew experienced was my relationship with a local chef, who we contracted to prepare food for breakfast, lunch, and dinner. The chef would show up at the rental house and have food ready by 4:30 a.m. so the crew could be out the door shortly thereafter. Then

lunch was served on the jobsite and dinner was ready when they returned. I feel this is important for morale when a crew is working out of town, doing what is already hard work and not having time to go get food. We don't always get this luxury, but we do strive for it in some form every time we work out of town. The crew loves it and we are happy to provide this as a small gesture of our appreciation.

A Final Note

Although a swimming pool can be built with a cast-in-place method, the shotcrete process greatly facilitates the installation, particularly when building a detailed pool that has multiple gutters, tight waterline tolerances, and a glass tile interior surface (Fig. 6).

In this case, reducing forming and, moreover, reducing time, was a serious benefit for the general contractor and owners, having lost so much time due to the previous situation. The shotcrete method was perfect for the construction of this pool. Trying to build the forms necessary for the vanishing edges and small gutters is possible but not nearly as efficient as simply building a one-sided form to shoot onto.

The added strength and durability of the shotcrete process, dry or wet, through the compaction of the concrete is of great benefit when dealing



Fig. 6: A mountain pool in the clouds

with a concrete shell meant to retain water—and chemically treated water at that.

At Revolution Gunite, our nozzleman and foreman is an ACI Certified Nozzleman, as was and should be required on a job like this. This particular foreman is responsible for thousands of pools over the last 20 years and his expertise shone when executing these details. We also

believe that a good shotcrete company should train its finishers and truck operators in what makes for a quality product so that everyone on board is qualified, not just the nozzleman.

Education, experience, and integrity are all key ingredients to a well-placed shotcrete structure. Shortcomings in any of these inevitably lead to failure of the structure and our industry as a whole.

The Outstanding Pool & Recreational Project

Project Name
Mountain Pool

Project Location
North Carolina

Shotcrete Contractor
Revolution Gunite*

Pool Contractor
Clearwater Construction Group, Inc.

General Contractor
Boone Construction

Architect/Engineer
Steven Carter Price, AIA, Architect

Pool Design Firm
Aquatic Consultants, Inc.

Material Supplier/Manufacturer
Norchem, Aquaron, and Flexcrete

Project Owner
Name withheld

*Corporate Member of the
American Shotcrete Association



Ryan Oakes is a Managing Partner in Revolution Gunite and is a licensed pool contractor in North Carolina and Virginia. Oakes has been designing and building water features in the United States and abroad, from pools to art

pieces and even aquaculture systems, for the past 17 years. With a mission to change the way gunite is perceived and applied, Oakes started down a path of education for himself as well as his staff. He is a member of the American Institute of Architects, the American Pool & Spa Association, and an active member in the Genesis Design Group, which educates contractors around the world in various aspects of the pool building process, including the shotcrete process. Revolution Gunite, a member of ASA and the American Concrete Institute, has a mission to not only educate and train its staff but to also educate its builders so that they, too, play their role in a quality shotcrete product. Revolution Gunite provides dry-mix shotcrete services to pool builders and other contractors in North Carolina and Florida, as well as parts of South Carolina, Virginia, and Tennessee.