

Outstanding Shotcrete Project Award Winner

2008 Outstanding Pool & Recreational Project

Canterbury High School

Every so often our company, Drakeley Industries, is confronted with a set of beliefs by some design professionals that the shotcrete process, particularly in the pool industry, is not viable for high-profile structural concrete. The pool market is viewed by many as saturated with less-than-qualified contractors and specification writers who mistakenly think that shotcrete compressive strength in psi (MPa) should be no more than your average high school student's SAT score. Mediocrity and its promotion in the pool market have made commercial institutions hesitant to use the shotcrete process. We came across such a case in Connecticut. A private high school was going to build a state-of-the-art aquatic center with a competition eight-lane tile pool as its focus. Its bid specifications originally called out for cast-in-place concrete. Our challenge was to sell our company as a qualified contractor, but more importantly, sell the shotcrete process.

The Canterbury High School project is a high school competitive swimming facility in the western hills of Connecticut. Our company was asked to submit a shotcrete structure for bidding purposes against and compared to a poured-in-place typical architectural specification. We leaped at the chance to show off why our concrete monolithic pool shell constructed with the shotcrete process was superior in many ways to the typical poured pool.

History has shown that cast concrete pools have expansion-joint and water-tightness issues that sooner or later produce a water loss that can never fully be repaired. Our aim was to prove to the specification writers that shotcrete was a viable solution to cast concrete in terms of water-tightness and longevity of the structure, as well as the finished surface bond ability. There is almost always a failure in the applied surface (tile or plaster) that started from a bond delamination that was initiated by water penetrations.

During the interview with the school's design group, a question arose from the engineering team regarding how or what we were going to use for an expansion or movement joint. Our response was "what joint?" We had to sit down and explain that one of the best advantages in the shotcrete process is that there is not an expansion joint or even a

bonding adhesive between days of placement. We explained that finishing an application from one day to the next included preparing the concrete in a construction joint format on a 45-degree angle and a gun or broom finish. All exposed steel would be clean of overspray and the previous day's shoot would be in a saturated surface-dry (SSD) condition to prevent any moisture exchange between the previously shot material and the new shotcrete. We elaborated on the bonding capabilities of the cement paste under such conditions. We explained that by using proper velocity of the shotcrete process to drive the cementitious product into the concrete of the previous day's shoot, this would in turn make for a tremendous physical and chemical bond.

A second concern arose as to how and what products our company was going to add to the concrete surface for a water- or damp-proofing agent against potential leaks. Test holes were dug prior to the specification writing and the groundwater table was found to be 2 ft (600 mm) higher than the bottom of the dig elevation during certain seasons. The answer again was "what agent?" The team's response was that if the shotcrete process is done correctly there would be no scenarios that would call for a water- or damp-proofing agent. Properly applied shotcrete will result in a high-density concrete that has very low permeability, very low porosity, and eliminates the need for a membrane designed to make the shell hold water. Cast-in-place concrete with porosity issues will call out for water-proofing. Referring to some of the ACI documentation, CP-60(02) "Shotcrete Nozzleman Certification," 506R "Guide to Shotcrete," and 506.4R "Guide to Evaluating Shotcrete," we were able to show the intended strengths and characteristics of properly placed shotcrete. Academia was now more educated but still hesitant about the process. It was time for our construction company to be the first player in the negotiations to differentiate ourselves from the competition. Our proposal was that we would guarantee that the pool would reach the minimum acceptable concrete compressive strength in 28 days and that the concrete would be watertight without the use of water-proofing agents. If those criteria were not met, we would demolish the pool

Outstanding Shotcrete Project Award Winner

and install cast-in-place concrete. Once the arguments were made and debated, the design team felt strong enough about the process to award us the contract.

Our construction sequencing started with excavation, drainage, and forming. All forms were solid, nonvibrating members that would ensure no shadowing or voids behind the steel reinforcement. Once forming was complete we installed the steel reinforcement. The walls and floor were 12 in. (305 mm) thick with a double matting of No. 5 (15M) and No. 4 (13M) bars, Grade 60, 12 in. (300 mm) on-centers offset between cages. The crew inserted polyvinyl chloride (PVC) chairs and wheel spacers to keep the reinforcing bar properly spaced, which allowed the necessary concrete coverage of each reinforcing bar. Guide wires were set for elevations and shooting depicting slopes of the floor and radius for the walls as well as the multiple levels of the bond beam.

Wet-mix shotcrete applications took 7 days to complete over a total span of 10 days. The mixture design called for a minimum of 4000 psi (27.6 MPa) after a 28-day wet cure. Installation started in the radius sections where the wall and floor met to establish the critical transition points. From there, the floor was shot in sections. The wet-mix process was chosen over the dry-mix process because our environment was somewhat controlled and we could easily apply a high-volume output with no strain on our finishers and reach the minimum designed compressive strengths. Once on the floor, we consolidated and leveled off each shoot with a power screed and then a very light broom finish. Tolerances were critical and everyone on the crew knew that the finish surface was all 1 x 1 in. (25 x 25 mm) ceramic tile. After each section shoot, we set up soaker hoses and kept the concrete in a saturated condition. This allowed the mixture water to stay in the concrete and promote the hydration process for optimal strength gain with no surface evaporation. As mentioned previously, each construction joint was in an SSD condition prior to receiving new concrete. Scaffolding was set up to build the walls. An excavator was kept with a long reach on site to remove all excess concrete after cutting and trimming and some rebound. Because it was a competition pool, the depths were very deep at 12 ft (4 m) and 7 ft (2 m) at each end, respectively, and we needed equipment help lifting out unusable material with those elevation depths. The pool required 350 yd³ (265 m³) of our special concrete mixture design over a 7-day period. The applicators were all ACI-certified shotcrete nozzlemen. Test samples were taken by



Cove wall and floor intersection on the first day of the project



Floor construction joint



Removal of rebound and concrete trimmings

Outstanding Shotcrete Project Award Winner

an independent lab hired by the high school. They did a typical concrete analysis including the compressive strengths of the samples. The first test sample was measured after 7 days in the lab. All involved were quite pleased with 6200 psi (42.8 MPa) test results. We cured the concrete for a 28-day period. Over the next week after the curing, the shell filled with water and remained water-tight. There is not one expansion joint in the pool and not one area that a chemical bonding agent was used.

After the mechanical systems were installed, we applied the tile interior with its setting bed

directly to the shot material. Because of the low permeability and the high density of the concrete, we did not have any issues with bleed water or bond ability to this shot surface. Having multiple layers of bonding agents or water/damp-proofing agents to properly-placed material will act as a bond breaker. Throughout construction, our goal was that, if done properly, our water-tight surface formed an excellent bond with the tile and its setting bed. This particular job and its specifications for the pool structure are now being used by this design team on other commercial projects around the New England area.

Raising the bar in the pool industry means the quality of the product must improve. Some organizations (such as the Genesis 3 Design Group) have embraced a higher quality in pool construction. For far too long, however, builders, designers, and pool professionals have neglected simple standards set forth by the American Concrete Institute. Entire organizations have built their business based on the notion that pool concrete is supposed to be porous, have minimal compressive strengths (less than 4000 psi [27.6 MPa]), and rely on some top coating to make the vessel hold water. This thought process and those who subscribe to it are exactly the reasons why the pool industry as a whole has never improved. Until all of us accept the fact that there are higher standards to be reached (as did Canterbury High School), we will never get by the prejudice against the shot concept.



Pool curing for 28 days



The finished product

Outstanding Pool & Recreational Project

Project Name

Canterbury High School

Project Location

New Milford, CT

Project Owner

Canterbury High School

Shotcrete Contractor

Drakeley Industries*

General Contractor

Drakeley Industries*

Architect/Engineer

Drakeley Industries*

Material Supplier

Sega Ready Mix

*Member of the American Shotcrete Association