# Project Profile: Underwood Pool Belmont, MA

*By Mason Guarino*

The Underwood pool in Belmont, MA, is known as the first outdoor public swimming pool built in the United States. It was originally built in 1912. Our recent project to renovate the pool was specified shotcrete as the knowledgeable pool design engineer wanted the capabilities of shotcrete. This job used all the best characteristics that shotcrete can offer from light formwork to bonding capabilities. We ended up using all of our shotcrete and pool construction knowledge to create a successful project for the Town of Belmont, MA.

When the bids came in, all the bidders but one were high. Then the lowest bidder decided to drop out when he saw how low he ended up being. The next low bid was about $400,000 over what was budgeted. However, being a relatively wealthy Boston suburb, the Underwood Pool Committee turned to the town for help to raise that last $400,000 required to get the job going. A local bank stepped up early, saying it would match every donation, so the town only needed to raise about $200,000 to fund the project. The town ended up raising the money in about a month and a half so the project could then proceed. The bad news was the delay in funding pushed the construction start time back over 2 months. This moved the start date for South Shore Gunite Pools & Spas, Inc. (SSG), and the swimming pool construction to late November.

As a swimming pool project, shotcrete was the obvious method for construction. It helped that the engineer agreed and had specified the project as a shotcrete structure. Fortunately, they did not specify wet- or dry-process shotcrete. This is a good practice because the shotcrete method should always be up to the applicator. SSG chose to go with the wet-mix method as this is a large project and the high production capability of wet-mix was needed. The project consists of two swimming pools: one was a 6000 ft$^2$ (560 m$^2$) water surface area competition pool with racing lanes with a 11 ft (3.4 m) deep diving well and the other was a 5000 ft$^2$ (465 m$^2$) water surface area wading/play pool. The project ended up using about 500 yd$^3$ (380 m$^3$) of shotcrete total. The final decision was whether or not to use ready mixed concrete. SSG has the capability of batching concrete material for shotcrete on-site and it is our preferred method. We chose to go with the on-site batching method as the space was available and the overall job made this approach feasible. Anything under 100 yd$^3$ (76 m$^3$) is typically a ready mixed job.

With a late November construction start and a complicated excavation, which included dewatering issues along with a complex form job, SSG was not able to start shotcrete placement until late December. Our original plan was to start on the larger pool and then move to the smaller pool whenever we could. This meant that some severe winter conditions protection would likely be needed. We hoped the snow would hold off.

The first step in the construction process was to form the floor as quickly as possible, as floor forms would go much faster than trying to build the entire form system Also, the wall forms could be attached to the concrete floor rather than attempting to drive stakes into frozen earth.

The second step was to install ground thaw hose in the 0.75 in. (20 mm) crushed stone layer under the pool. The ground thaw hose was installed in loops at 12 in. (300 mm) on center runs. This process ended up using roughly 5000 ft (1500 m) of ground thaw hose that would be drained and buried at the completion of the project. The ground thaw hose was connected to a glycol heating unit that gave us a constant ground temperature of roughly 50°F (10°C) on the coldest days.

The final step to protect the area to receive the material was building a temporary tent that would trap some heat and keep out some of the cold air and elements. Ropes, braces, and 100 x 60 ft (30 x 18 m) woven tarps were hung over the entire area and six to eight heaters were placed under the tent to help keep temperatures up (refer to Fig. 1).

On typical cold weather projects, we would keep the ground and reinforcing steel warm by laying down thermal blankets until we got to the area, placing the shotcrete, and then covering the fresh shotcrete as soon as it was finished to trap in the heat. This project would require a steel trowel finish so laying anything directly on the fresh shotcrete was not an option.

Jobsite temperatures ended up averaging between a high somewhat below 40°F (4°C) and

*Fig. 1: The tent to help trap heat*

a low around 20°F (–7°C) on a daily basis. Finally, we had to produce warm concrete that would set in cooler temperatures. Our mobile concrete batch truck has a water tank that used water circulated through a jobsite water heater so all of our mix water ended up being approximately 100 to 120°F (38 to 49°C). All concrete sand and crushed 3/8 in. (10 mm) stone was stored overnight indoors at our warehouse at 50°F (10°C) to keep the material from freezing or even being too cold. Additionally, we used a water reducer that contained a mild accelerator additive.

Once the shotcreting began, we made good progress installing the floor. We chose to shoot the floor because of the many different sloping angles in the floor along with the need for monolithic construction. Some of the areas would be very difficult to cast monolithically with traditional slab construction. SSG shot the floor in 10 ft (3 m) wide strips, taking meticulous care at the joints to maintain a steel trowel-paintable finish upon completion. The edges of the slab were left 3 in. (45 mm) low for the outside 6 ft (1.8 m) to accept the wall shotcrete when the time came. The floor was installed in the week between Christmas and New Year's. The compressive strength test results for the floor were approximately 8000 psi (55 MPa). Once the floor was complete, the crew moved into constructing the wall forms. The wall forms consisted of 1 x 3 in. (25 x 75 mm) rough-cut lumber construction using 1 in. (25 mm) thick rigid foam insulation to help the concrete trap in as much heat as it could while working under a tent. Once the forms were complete and ready for shotcrete, the snow hit. Boston's snowiest winter ever began burying the jobsite in roughly 3 ft (0.9 m) of snow in the first storm and then receiving another 3 ft (0.9 m) of snow 2 weeks later, putting a complete halt to construction and completely negating the use of the rigid foam insulation forms. Boston, roughly 10 minutes from the jobsite, would go on to receive roughly 10 ft (3 m) of snow in the first 4 months of 2015.

The job wouldn't resume again until late April, when the snow finally started to melt and we shoveled off the work area. This delay left our floor exposed for over 3 months to the severe weather, a surface that would then be shot against to maintain a monolithic pool shell. Unfortunately, the jobsite sat in a low, tree-covered area which substantially hindered the melting of the snow. Shotcrete resumed once normal spring conditions started, and made the working conditions much more comfortable and easier to work with. However, there was still the task of creating a steel trowel-finish pool construction.

The wall thickness ranged from 8 to 24 in. (200 to 600 mm). With the varying wall thicknesses, we knew that set times and final finish times would vary significantly. To counter this, SSG decided to go with the layering technique. SSG started by completely cleaning the surface to be shot against to continue the wall of the monolithic pool structure (refer to Fig. 2).

When shot, the floor area immediately under the wall was intentionally left very rough. This area was heavily power washed to remove anything that could hinder a bond. A bonding agent does not need to be used as properly applied shotcrete will adhere to old concrete as if it were

*Fig. 2: First layer is ready to receive its final layer once SSD is achieved*

*Fig. 4: The final layer shot and cut, waiting to receive steel trowel finish*

*Fig. 3: A core sample from the pool wall where layering was done. Shows excellent reinforcing bar encapsulation and no actual layers*

*Fig. 5: The steel troweled final finish*

shot against fresh concrete/shotcrete. A blow pipe would be used to keep the receiving surface immediately ahead of the nozzleman clean of rebound. The blow pipe would continue to be used throughout construction as the wall reinforcing was No. 4 and 5 (No. 13M and 16M) bars in a 12 x 12 in. (300 x 300 mm) pattern with both front and back layers. To use the layering technique, the first layer of wall would be shot to just cover the first layer of reinforcing bar, leaving about 1.5 to 2 in. (36 to 90 mm) of thickness to go. Because shotcrete bonds so well to itself and other concrete, using shotcrete made this process very easy (refer to Fig. 3). The layering technique allowed the material to be installed faster and for the finishers to work with a uniform concrete material that set up nicely and was predictable. This allowed the finishers to work roughly three times faster than if we shot the full thickness of the wall at one time. This method also made it easier for the finishers to achieve a straighter more accurate wall (refer to Fig. 4 and 5).

Shotcrete was key to building a quickly executed, profitable project. The limited amount of forming kept us moving fast, and the fact that we did not have to deal with any honeycombing or form irregularities on the interior finish wall allowed us to not do any work twice. The layering technique allowed us to maintain an accurate, smooth finish that, once complete, provided an excellent look with the final coat of paint. Our shotcrete success in both the wet and dry process would not have been possible if it were not for the support of the American Shotcrete Association, ACI Certified Nozzlemen, and ASA's highly knowledgeable members.

***Mason Guarino*** *started in the pool industry when he was 14, learning how to install reinforcing bar. Since then, he has worked on all phases of swimming pool construction. Guarino has been with South Shore Gunite Pools & Spas, Inc., full-time since graduating from the Wentworth Institute of Technology with his BS in construction management in 2009. Guarino currently serves on ASA's Board of Direction and is an ACI Certified Nozzleman.*