2019 Outstanding Pool & Recreational Project

Purlear Creek

By Ryan Oakes and Anna Ploghoft

In North Carolina, we are quite fond of our local swimming holes. Ask any Tar Heel, and they will assuredly regale you with tales of their childhood spent swinging wildly from ropes and jumping from or sliding down boulders. The swimming hole always held magic for us when we were small, with water that glowed with microscopic fool's gold, and tiny fish that would nibble at our feet. It was a place where we could run, jump, and splash, all while nature was busily oiling the wheels of our young imaginations. It's a scene that one North Carolinian couple wished to recreate for their grandchildren, right in their backyard.

THE INTERVIEW

We were contacted by a prospective client in early 2017 who wanted to build a swimming pool on the hill behind their house. They knew they wanted a pool, but also knew that with the natural beauty of the property they had purchased, the last thing they wanted was to construct something that stood out as built. The center of the project quickly revealed itself as the hill. The client's grandchildren had made a tradition of using makeshift sleds to slide down the leaf-strewn hillside adjacent to their cabin during the fall months, and the client made a point of wanting to preserve the spirit of this activity in the new design. They had also expressed their enjoyment of hiking down the hill to a waterfall, though the hike itself is pretty grueling. No less important to the project was a need to provide a place for activity through multiple seasons. It is the Blue Ridge Mountains, after all, and the summer season is short relative to the rest of the state.

DESIGN

We started, as always, with an idea of how the project should be used, then drafted a hand sketch. We presented to the client a concept of a multi-tiered creek and a hillside boulder garden for spring, summer, and fall fun. In-between two tiers of the pool would sit a large rock from which to slide and jump, therein preserving the spirit of the downhill leaf-sledding tradition. The "boulders" would be carved with the help of experienced rock climbers and artists, creating the opportunity for the children to test their strengths year-round. Our client was thrilled and immediately wished to move forward with the project.

Once the hand sketch was done and the concept was established, we immediately went to work doing a three-dimensional (3-D) scan of the property and drafting 3-D models of all the boulders and watershapes, the spa, the creek, and the pool. Simultaneously, we visited various local waterfalls, creeks, rivers, and boulder outcroppings for ideas and inspiration to draw upon.

Once a model was settled upon, we were able to go to engineering and determine the quantity of reinforcing steel, concrete, and other materials for the project. As well, we immediately began determining how we would service such a project.

LOGISTICS

Even though we use the dry-mix shotcrete process, when working out of town or anywhere that we don't have our own satellite batch plant, we coordinate with local ready mixed plants to get raw concrete materials. Here, however, we were on top of a single mountain, an hour away from the nearest possible reload point, and we had a few other variables that led us to the solution of setting up a temporary batching site. One of these variables was the sheer size of the job—this project used nearly 3,000,000 lb (1,360,000 kg) of concrete! Daily construction progress over the course of 18 months would also prove hard to predict.

Though the project spanned over 18 months, the actual shotcrete components happened intermittently over 9 months and ranged from a day to a few weeks at a time. Thankfully, the neighborhood is still under construction and the developers allowed us to use an empty construction lot to stage hundreds of tons of aggregate, a portable silo, a water tanker, and a loader so that we could batch our trucks less than a mile from the jobsite (Fig. 1). This allowed us to minimize trucks needed to service the job. We kept no more than two volumetric batch trucks at any given

Fig. 1: Local aggregate staging area for volumetric batch trucks

point during the pool construction and only one batch truck during the rockwork component. One compressor and one rotary barrel dry-mix gun were on site at all times. We also kept a rotary bowl dry-mix gun on site for backup.

We shot the main pool first and worked our way back up the hill for the creek and spa, but then went back down months later to begin the rock work.

Once we resolved the construction access challenges, such as this being a very steep hill, with the lowest work being over 130 ft (40 m) below the truck and gun locations, and over 300 ft (90 m) away from the truck, we began to work on concrete mixture designs to achieve the performance qualities we wanted.

Mixture Design

Rock carving is a slow process, involving a great deal of starting and stopping over the course of a day. The dry-mix shotcrete process was an essential method providing us the flexibility to shoot long distances, in extremely awkward places, and start and stop at leisure. We would sometimes only shoot one truck of material over the course of a 12-hour day.

Typically, on larger, more production-oriented projects, the level of detail is lower than that of smaller-scale residential projects where a client is viewing the work more closely. But being a large-scale residential project with the need for a high level of detail, we needed to be able to carve for an extended duration of time. To achieve a slow set time and not hinder long-term strength gain, we used a blend of 30% slag cement and 70% portland cement. The slag cement slows heat of hydration and provides us plenty of time to carve yet still stack the material. We could carve for hours after placement and even make changes and details the day after placement. The slag cement also helps to decrease permeability, which is ideal on a project that is in large part underwater or has water flowing over it. Cores from test panels that were shot without other supplemental cementitious materials (SCMs) would show the slag blends to produce long-term break strengths over 11,000 psi (76 MPa) as well. Being able to incorporate a product as sustainable as slag cement, a by-product of the steel industry, into such a large-scale project was a real plus.

To reduce rebound and increase density even further, we replaced 5% of the portland cement with silica fume. This helped significantly reduce rebound, which helped counteract the slight increase due to the slag blend. The silica fume also helped us to stack material more thickly for interesting rock features and further decrease the concrete's permeability. The addition of jute and hemp fibers further aided stackability, though the primary reason for this addition was to help reduce shrinkage cracking. We used 2.2 lb/yd^3 (1.3 kg/m^3) of natural fibers.

Though we had a great reinforcing steel schedule for our structural shotcrete thickness, our carve coat didn't have any reinforcing steel. The thickness of the carve coat can range from 1 to 9 in. (25 to 225 mm) in thickness. In over 9000 ft^2 (840 m^2) of rock carving, we experienced almost no visible plastic shrinkage cracking and practically no efflorescence. We attribute this to the use of our mixture design as well as using best practices for application, including good nozzle technique with ACI-certified shotcrete nozzlemen along with fervent use of the air lance, in some cases even using two air lances to keep rebound and overspray clear of connection points from previous work.

Man-made rock work, commonly referred to as "artificial rock," "fake rock," "zoo rock," or "Disney rock," is often rife with efflorescence and shrinkage, especially when it is carved by hand as opposed to using GFRC panels and mending them together. We were excited to see such minimal shrinkage cracking in our project after completion.

From Concept to Completion

Creating man-made rock is an exceptional concept from start to finish. The details we see as a finished product are typically visualized long before the coloring of the project. In fact, they are almost entirely set in motion from the steelwork or formwork, which relies completely on good design.

The academic version of the process goes like this:

1. Inspiration
2. Vision
3. Rendering/modeling
4. Formwork
5. Reinforcing steel (though some skip this step)
6. Structural section to embed the reinforcing steel and initiate form
7. Carve coat or stamping for form and detail
8. Coloring or staining and other "tricks of the trade"

For us, the inspiration started over 25 years ago when I began climbing. I became immersed in the Appalachian bouldering and climbing scene and met some of the most influential climbers of the day. Two of those individuals would come to find a place on this project, Joey Hinson and Peter Glenn Oakley. Coming back to university after a hiatus, the discovery of rock climbing helped define my character. It created a mind-body connection that I had not acknowledged before, along with deep friendships and understanding of physics that only climbing can extort. I went on to climb around the world, including some great heights like El Capitan in Yosemite Valley, but bouldering in the Appalachians is the distilled version of all forms of climbing. And so, when this project came along, it was natural that those boulders, indelibly ingrained in my mind, would find their way to paper. Hinson is still an active boulderer of international fame, and makes a living in part, drawing boulder fields that he had a part in discovering and developing. So, when I had this idea, I enlisted him to take my hand draft and make it more artful with his style. The client loved it. Unfortunately, building an entire boulder field, with a vanishing edge spa, a creek, and a vanishing edge pool on the side of a mountain accurately, can't really be done from a hand drawing. From there we went through 14 iterations of CAD models in a building information modeling (BIM) software called Revit. This provided us the ability to narrow down the accuracy and placement of the entire structure as well as track its construction progress through surveying during the 18 months it took to build.

One of the key components to designing with BIM was that we could take research gleaned from local rivers and sliding rocks (Fig. 2) we knew and apply it to our computer model. We knew it was easy and fun to slide down Turtle-back Falls and Sliding Rock in Pisgah, NC, so we studied the angle of those renowned locations. Then we looked at the friction point of polished wet concrete and the maximum static friction value of an adult versus a child to determine what angle would work for our project and how much we would need to polish the surface after placement of the concrete where the slide in the boulder would provide a safe but fun speed.

Though this entire project was modeled in Revit and daily survey points were established and lost and re-established through full-time surveying by our superintendent, this was still an art project, and it proved to be very dynamic in this regard. Bending reinforcing bars in forms other than 90 degrees and with completely random placement requires a sense of the finished project, so we not only used our staff, but we hired local climbers and recruited the help of our friends at Artisan Skate Parks. Having workers who tie reinforcing steel in compound curves on a daily basis was immensely helpful, and having folks who climb and have an intimate knowledge of natural boulder formations was indispensable. To get our pool building staff, the skaters, and the climbers all on the same page, I used modeling clay, along with the help of Hinson, to create an image of the project to guide everyone to a similar vision, beyond all of the 3-D rendering and video imagery (Fig. 3).

Raising the Bar

Before embarking on this project, I must mention that though we had experience in carving rock and the clients had seen our previous work and loved it, we wanted to raise the bar. We felt that a project like this, being in the mountains, so close to my old stomping grounds, with the pool and the vista beyond, deserved to exceed the clients' expectations. A friend of ours turned us on to Ocean Rock Industries, out of British Columbia (BC), as real heroes in the man-made rock world, so I reached out to the Owner, Dan Pitts. He embraced the idea and we arranged a consulting relationship for this project, where he would teach us some "tricks" and coach us through improving our game, from the structural sections to the carve coat and especially the coloring. Pitts, having mentored under a world-famous carver himself, had much to share. And, when it came time to shoot, Pitts came to North Carolina to supervise the work which he had coached us in. The very first thing we did was to take him to a private boulder field near Hinson's home and show him around. We had him climbing and feeling out our rock, which differs so greatly in every aspect from the Western BC rock that he is familiar with. This intimacy would prove to be invaluable in our carving because we needed to align his vision with

Fig. 2: Researching the North Carolina rock

Fig. 3: Clay model of the project

ours. We also visited the boulders and waterfalls further down the property, which helped inspire the project from the beginning.

Our carve team included me (Ryan Oakes), Oakley (friend and climbing companion of 25+ years and famous marble sculptor), and Hinson (geologist, artist, and world-famous boulderer), all under the very careful eye of Pitts. We had others helping as well; the list is long, and the support team was invaluable in this process. From rebound removal to air lance operating to reinforcing steel adjustments and the ongoing dynamic of carving rock, the process was labor-intensive.

Shooting these features turned out to be a little trickier than we had initially conceived. However, thanks to having a bunch of climbers around, we made quick work of some of the more logistically challenging aspects and even found ourselves putting nozzlemen on rappel (Fig. 4) or being harnessed and tied off by rope while hanging over the edge of a previously shot boulder. We maintained a steel safety line to connect climbing leads and belay devices through the duration of the project. These would stay in place all the way through to coloring before finally cutting safety anchors out and patching the holes so that the coloring effects would hide any evidence of their existence.

In safer but more physically difficult placement situations, our nozzlemen found themselves laying on their backs, shooting upside down directly overhead just a few feet away. This makes for a bit of messy work but thinking of any other way to achieve the finish qualities is unreasonable, to say the least. The shotcrete process is the only practical way to make this high-quality, durable concrete placement happen.

Fig. 4: Nozzleman shooting the steep rock face while being suspended on belay

The flexibility of the shotcrete process allows the artists themselves to grab the hose and nozzle the material to a much closer specification than trying to translate to a nozzleman who may not share their own particular vision for the finished product. The artists would, of course, be under close supervision by a trained nozzleman, but again, this flexibility is one of the true beauties of the shotcrete process.

Conclusions

Over 9000 ft^2 of artisan-carved rock were installed in and around a water feature of 70,000 gal. (265,000 L), including a 12 ft (3.7 m) deep vanishing edge pool with a 14 ft (4.3 m) high jumping rock (Fig. 5).

The pools all have concrete compressive values ranging from 5000 to 7500 psi (34 to 52 MPa) while the rock work has compressive values ranging from 6500 to 11,440 psi (45 to 79 MPa) and higher.

Fig. 5: Overview of the project near completion

Over 700 yd^3 (540 m^3) of concrete, weighing nearly 3,000,000 lb, were placed using the dry-mix shotcrete process (Fig. 6).

Specialized mixture designs allowed us to place concrete and carve for hours without initial set interference. Even next day manipulation was possible to some degree.

Practically no formwork was used for the rock work and minimal formwork was needed for the pools. Altogether, this was a project that took our vision of what could be achieved and through research, modeling, and hard work turned that vision into a high-strength, durable concrete "swimming hole" that looked right at home in the North Carolina mountains (Fig. 7).

Fig. 6: Bird-eye view of the finished project

Fig. 7: The brand new "ole swimming hole"

2019 OUTSTANDING POOL & RECREATIONAL PROJECT

Project Name
Purlear Creek

Location
Purlear, NC

Shotcrete Contractor
Revolution Gunite*

Architect/Engineer
Clearwater Construction Group and Watershape Consulting

Materials Supplier
LafargeHolcim and Natural Reinforce Fibers & Co.

Equipment Manufacturer
Gunite Supply & Equipment* and King*

General Contractor
Clearwater Construction Group, Inc.

*ASA Sustaining Corporate or Corporate Member

Ryan Oakes *is a Professional Watershape Designer and President of Clearwater Construction Group, Inc., Revolution Gunite, and Revolution Pool Finishes, all of which are award-winning firms in their respective trade. Oakes is a faculty member at Watershape University, where he continually aims to raise the bar in the swimming pool and the watershape construction industry. As a member of the leadership team for the International Watershape Institute (IWI) and through educational outreach to a vast pool builder network throughout the United States, he aims to improve the building techniques and methods of constructing swimming pools. Oakes is a member of ACI Committee 506, Shotcreting, and ACI Subcommittee 506-H, Shotcreting Pools. He serves on the ASA Board of Directors and also serves as Vice Chair of both the ASA Pool & Recreational Shotcrete Committee and the ASA Contractor Qualification Committee.*

Anna Ploghoft *received her BA in biology from the University of North Carolina at Greensboro, before studying architectural engineering technologies at Norwalk College, Norwalk, CT, in 2014. Specializing in fluid engineering, BIM design, and CAD design, she has been designing for Clearwater Construction Group since 2017.*