



## Are Feathered Edges Ever Appropriate?

By Ryan Oakes

The perfect storm... My deadline for this article was looming and I was called to duty, as a batch truck driver injured his finger the night before. The job was 4 hours away, so I was out the door at 4:00 a.m. to get to our shop. It was for an important client who was trying to get his pool shell in before a tropical storm made landfall. You can see where this is going.

This was an 80 to 90 yd<sup>3</sup> (61 to 69 m<sup>3</sup>) pool—a size our crew can handle in a day. The majority of the crew arrived the night before and the rest left at 3:00 a.m. All was well until I showed up a little late due to a couple fuel stops, school buses, major traffic slowdowns... No worries, we can still pull this off.

The tropical storm was sitting right on top of us but not doing anything threatening, so we studied the radar and pressed on. Approximately 10 miles (16 km) away, Wilmington, NC, was experiencing inclement weather with several inches of rain. We dodged the bullet, or so we thought. Later that

day, the volumetric batch trucks were held up in traffic between the reload yard and the jobsite, adding more time to get the job done. Then, as we were nearly complete with only 15 yd<sup>3</sup> (11 m<sup>3</sup>) to go, an auger broke on one of the batch trucks and a bearing went bad on another one.

It was late, and the crew only had 3 hours of sleep the night before, so we stopped the shotcrete placement. The crew immediately began properly prepping all shotcrete surfaces for the following day. Unfinished walls were benched off at a 45-degree angle. Receiving surfaces had laitance removed and were roughened with a notched trowel. The floor was given a broom finish. Before brooming the floor, the finishers went around the edge of the pool where walls had not been shot and lowered the surface by 1 in. (25 mm) so that there was a shoulder for the cove to meet the floor on the next day. We sent the full batch truck home and didn't put the last batch truck in the pool excavation, deciding it would be best to have it ready for the next morning while the other truck went for a reload.

The next morning, we started prepping the receiving surfaces and pool shell for new shotcrete placement. An hour later one of the batch trucks' tire blew out and another subcontractor on the project broke the water main, causing the loss of the on-site water supply. Fortunately, our batch trucks have water tanks so we drove to a nearby concrete plant and filled the water tanks. We finished later in the day after placing a total of 93 yd<sup>3</sup> (71 m<sup>3</sup>).

### THE LESSON

It probably goes without saying at this point but, things don't always go as planned. It's construction—what could possibly go wrong?

There are numerous reasons we stop and start our work in structural shotcrete placement. Pools are no exception. Pool projects are becoming more complicated. Designers add many details that make pool construction more intricate. As a result, pools are sometimes larger than can be placed in one day. On-site

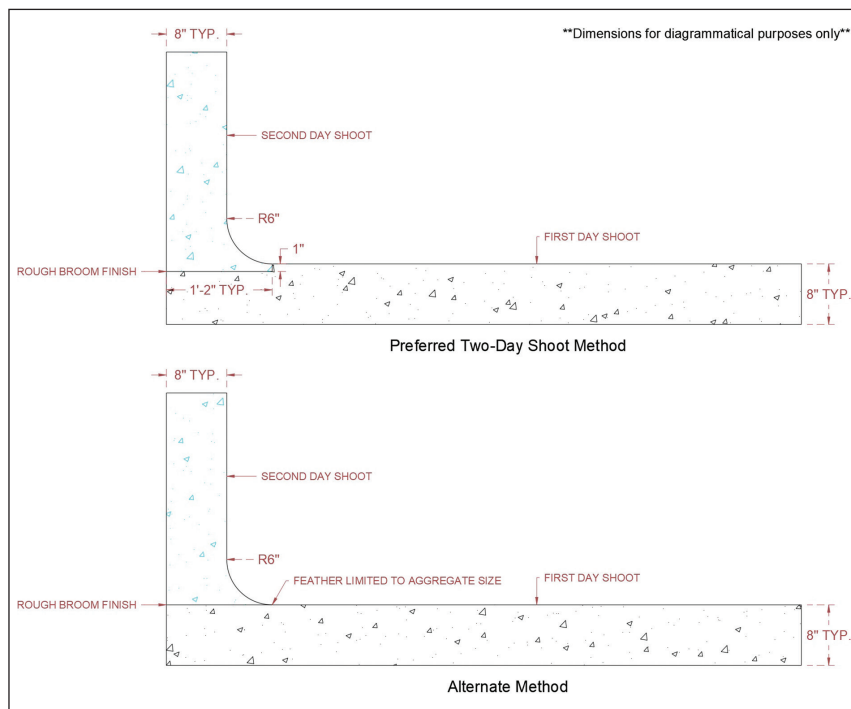


Fig. 1: Top section drawing is the preferred detail showing a 3/4 in. minimum shoulder where the cove meets the floor. The bottom section shows how the feathered approach will look when properly executed

productivity issues such as equipment failure, materials delivery problems, or a looming rainstorm can severely affect production and shut down a job quickly. These are just a few examples of why we might have unintended placement delays or full stops.

ACI and good industry practice has established guidelines for dealing with construction joints when stopping and then restarting shooting. We completely support these guidelines. However, as noted above unplanned events can (and will) on occasion impact a job. In some cases, a solution is needed that provides the best possible quality and durability though perhaps not as optimum as it may have been without the extenuating circumstances. Particularly, I am referring to dealing with the leading edge of fresh material to existing material in an unplanned construction joint. An example of this location is the cove of a pool. The accepted practice is to create a shoulder in the initially shot concrete of at least 3/4 in. (19 mm) so that the leading edge of the subsequently placed concrete is at least 3/4 in. thick where it abuts up to the existing concrete and does not “feather” out to zero. This is the best method and should be followed whenever possible. However, when all else fails, feathering an edge in some applications, if done well and with close attention to detail, is a method of creating a serviceable construction joint in a swimming pool.

## SHAPES, SIZES, AND FLOORS

In a rectangle pool with a set and specific radius cove, where one knows they are going to shoot the floor first and walls the next day, it is possible to cut a shouldered edge in the floor for the subsequent wall placement. This increases the time and effort needed to prep the joint and may require extra finishers but is needed to provide the best possible joint. In a curvilinear pool with a varying and compounded floor pitch and multiple protrusions in the wall, such as benches, swim outs, barstools, steps, and water features, it becomes more difficult to create the shoulder. It is certainly harder to predict exactly where all these termination points of the floor are going to be. Without close attention to the stopping points, the concrete may set too fast on a hot summer day for the crew to carve the shoulder at the transition.

Also, sometimes (as discussed previously) a shotcrete crew must stop unexpectedly. After the concrete in the floor has hardened, coming back and chipping or sawing just to produce the shoulder may create more internal damage to the concrete than justified by having a reduced thickness at the transition.

Often, commercial pool floors are cast by the pool contractor, calling the shotcrete contractor in only to shoot the walls. The pool contractors I've dealt with rarely spend the time and effort to produce the shoulder at the joint. Right or wrong, this is what we must deal with when we show up to shotcrete. We can ask the contractor to properly prep the joint to create the best possible joint, but some builders are unfamiliar with the industry practice or simply don't want this done as they are unwilling to spend the extra money for the labor intense demolition to create a shoulder

in a hardened concrete surface. Unfortunately, some shotcrete contractors will simply shoot the walls with no prep whatsoever and without knowledge of proper procedures to create a feathered edge successfully. This bodes badly for the entire shotcrete industry. Thus, in this article I propose an alternative method of dealing with these much less than optimum conditions which may necessitate producing a feathered edge.

## THE FEATHERED EDGE

To be clear, good industry practice, as documented by ASA and ACI, does not recommend using a feathered edge at a construction joint. If one encounters a situation where there are no other practical options this technique may be helpful to complete the job. However, this should never be a practice that is planned on by the shotcrete contractor *before* shooting the pool. It's like that box on the wall that says, “In emergency break glass” and you pull the alarm.

Knowing why it shouldn't be used as well as how one may best use the technique can be a valuable tool for a highly-skilled shotcrete crew when shooting swimming pools. Also, a technique that works for a dry-mix shotcrete application, may not necessarily work for a wet-mix shotcrete application, because a dry-mix application typically has smaller aggregate and therefore can allow a thinner edge.

If a shotcrete crew feathers a new edge out over an existing well-prepared concrete surface with proper application, the thickness at the edge should be limited to the size of the aggregate. Because proper shotcrete placement forces the cement-rich paste at high velocity into the existing surface the leading edge of new material is bonding to the existing material. If the nozzleman shoots past the point that is going to be feathered to zero (or close to zero), and the finishers cut back to the tapered edge, there is still the bond of the new concrete to the existing material.

This is not a new practice, and several shotcrete companies, both wet- and dry-mix, have been using this technique for years though unfortunately not always with good technique or results. I have been back to jobs that our company shot, 28 days or later (before plaster) to look for failure in using this technique on our own work and found them successful. In applications where we had excellent preparation, material placement, and curing I had difficulty finding where a feathered edge existed in the final joint. Where our application was less than perfect one can see the edge is fragile and breaks back to about 1/8 in. (3 mm) or at most 1/4 in. (6 mm) from the termination of the secondary placement. My experience suggests that variation in aggregate can significantly affect the performance of a feathered edge. Thus, understanding your concrete mixture design will help in understanding how to apply the material as well as what its limitations are. Because aggregate size in the dry-mix shotcrete process is typically a little bit smaller, it will likely work better than when using a wet-mix shotcrete with larger coarse aggregate sizes. I also have noticed that using silica fume in the concrete mixture will help improve the bond of a feathered edge.





Fig. 2: In this application the procedure was done well enough that at 28 days, the connection point is hardly perceptible

During plaster prep, nuances or variations in shotcrete work are resolved by the plaster, tile, or stone prep crew; therefore, having a 1/4 in. broken edge generally falls within the acceptable finished tolerances of the shotcrete pool shell. The concrete shell is just that—it's a shell. The surface is going to be covered so a perfectly smooth surface is not necessary. A good, solid surface with no voids and a good bond between joints is necessary to create a watertight vessel that is structurally sound. You should strive to provide a final surface very close to the finished tolerances required by the pool builder to minimize prep by pool work that follows shotcreting.

It is important to understand which trade is coming behind your work. For example, with subsequent plaster application, it is ideal to minimize variance in the interior surface so that plaster does not hydrate unevenly or create small edges that can cause reentrant cracking in plaster surfaces. In tile, it is ideal to minimize variances as well, so that tile setters don't have to float the grout excessively and require an expensive buildup of materials to perfect their interior substrate.

## PROBLEMS WITH FEATHERED EDGES

Problems using a feathered edge may and are likely to arise if the most stringent care and attention to detail is not used. If rebound or trimmings are not removed and the nozzleman is not willing to stop and continually clean the surface while applying the edge, then poor quality concrete materials may get incorporated at the interface. This will likely be discovered during the plaster prep through high-pressure washing, acid washing, or hammer sounding the joint with a hammer. It is also possible that these same problems will



Fig. 3: This is the preferred method that a crew should be ready to install on 2-day projects when possible

occur if the nozzleman does not use correct technique when flashing a pool for a finished surface.

## PROBLEMS WITH SHOULDERED EDGES

The greatest problem with creating the shouldered edge is circumstance. Many contractors may simply not be educated on why a shouldered edge is best practice. It may be due to unexpected short staffing or running out of time in the day. Problems can also arise when a shotcrete contractor does not understand how to keep rebound away and simply traps it in the shouldered area. It is easy to trap rebound in a tight space like this and supports the idea that the shotcrete contractor should be qualified for the job and employ an ACI-Certified Shotcrete Nozzleman.

## CREATING A FEATHERED EDGE

Before explaining how we have managed to successfully create a feathered edge, I want to reiterate that neither ACI nor ASA recommend using a feathered edge. The prescribed method is to cut a shoulder at least 3/4 in. deep in the existing surface. This is the method we routinely use. However, when unforeseen circumstances arise to warrant the use of the feathering technique this is what we do when using dry-mix shotcrete.

Our dry-mix nozzleman first preps the existing surface with high-pressure air and water blast from his hose. Then the air lance (blowpipe) is used during shotcrete placement to continually remove overspray and rebound. If the rebound and overspray builds up to amounts that the air lance cannot easily remove, a finisher should be readily available to pull the excess away from the shotcrete receiving surface





Fig. 4: Cleaning the surface area with high-pressure air and water. This process gets the substrate to a clean SSD state. This is essential to achieving a solid bond between the new and existing material



Fig. 6: Maintaining a clean substrate is a very active procedure. It helps to have a finisher using a Fresno to remove excessive rebound



Fig. 5: Using an air lance is critical to maintaining a clean substrate during the shotcrete process. Without the air lance the substrate will develop a layer of overspray and rebound that will prevent bonding of the new material to the existing material



Fig. 7: Once the cove is shot in place, a level and tape are used to verify the dimensions of the wall



## POOL & RECREATIONAL SHOTCRETE CORNER



Fig. 8: Finishers remove the excess material from the cove to handcraft the shape and feather the cove down to the floor



Fig. 9: A finished cove and wall shot in place on the second day of a shoot

and removing it from the pool. The air lance also removes excess water and can help to maintain a saturated surface dry (SSD) condition to receive the material. Laying down a nice bed of material for a long run of a joint will help the nozzleman build up the wall as if they were shooting against all new material on the floor. Constant attention is needed to achieve a good bond and an acceptable surface. Without an air lance this method is simply not possible.

All other ACI guidelines are followed to help ensure excellent bond at the joint and preventing a cold joint. Having a properly benched off surface, roughened, cleaned from all debris and laitance, and with reinforcing bar that is clean of all overspray is essential to successful performance.

### A CLOSING THOUGHT

Decades of successful placement with a 3/4 in. shouldered edge has proven the ability to have construction joints that act monolithically while providing long-term strength and durability. I encourage builders to follow it whenever possible. Don't take shortcuts using a feathered edge to save time or effort on a job because it will reduce the durability and performance of the final joint. "In Case of Emergency" consider all options and if feathering a joint edge is the only solution make sure you pay careful attention to all the details in prep, placement, and curing.

Swimming pools are not simple concrete rectangular pools anymore. Pools are becoming more complicated than ever with details such as vanishing edges, perimeter overflows, raised bond beams, underwater rooms, artificial rock, built in aquariums, shallow water lounging areas, beach entries, or water features. The more people and trades we involve in any field construction project, the more likely we will run into surprises and situations that call for creative

approaches. We must as an industry accept that consistent high quality and durability of our pool shells is the ultimate challenge. We must rise to that challenge and always find a way to achieve the best possible results. As shotcrete contractors we must always stress to the pool contractors before they pour a floor that the shoulder at the edge is critical to producing the best quality, most durable joint. Our reputation as contractors and our reputation as an industry depend on it!



**Ryan Oakes** is a Managing Partner at Revolution Gunite and is a licensed pool contractor in North Carolina and Virginia. Oakes has been designing and building watershapes in the United States and abroad, from swimming pools to art pieces and even aquaculture systems, for the past 20 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 Revolution Gunite staff. He is an active member in the National Swimming Pool Foundation's Genesis University, which educates contractors around the world in various aspects of the pool building process, including the shotcrete process. Oakes is an SWD Master (Society of Water-shape Designers) and an Allied member of the American Institute of Architects and member of the American Pool & Spa Association. 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 the ASA Contractors Qualification Committee and ASA Pool & Recreational Shotcrete Committee.