High-Production, Quality Shotcrete

By Bruce Russell

High-production shotcrete projects are amazing to observe; when operating at optimum level, it appears to be very simple. Those of us in the shotcrete industry know better; there are many well-trained people and detail-based processes required to make it all happen. The following is a brief layout of what it takes to operate as a high-production shotcrete contractor while producing the highest quality product.

Fig. 2: Shop - Gainesville, FL

SUPPORT STAFF

Office

Our office staff is responsible for all the behind-the-scenes tasks that keep the company running smoothly. These tasks include, but are not limited to, the following:

- Business Development
- Project Management
- Quality Control
- Accounting
- Team Services
- Engineering
- Bidding
- Risk Management
- Estimating
- Internal Support
- Drafting
- Safety
- Software Development
- Marketing

Fig. 2: Shop - Gainesville, FL

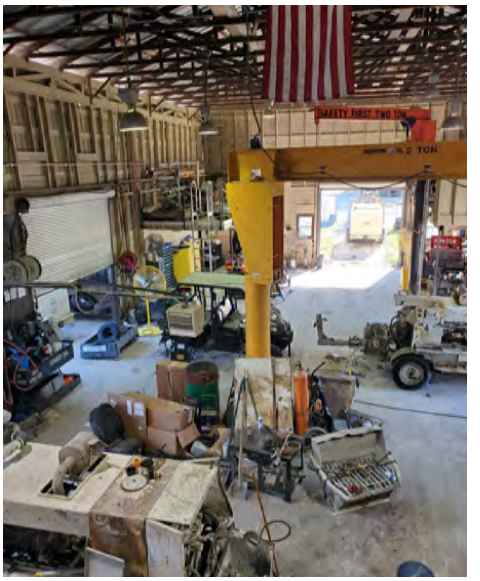


Fig. 3: Shop - Gainesville, FL

The 120 individuals that are part of the office staff mentioned above are responsible for finding the opportunities, designing, bidding, managing, billing, paying bills, and ensuring everyone gets a paycheck every week. Without each and every one of the team members mentioned above performing at a high level, our company couldn't execute the field projects successfully.

Shop

Without all the 75 hard-working individuals at our shop who are developing and maintaining our equipment, our field crews would not be able to produce the high-quality work that we are known for.

Here are some of the primary responsibilities of our shop team:

- The Shipping and Receiving team
- The Mechanics team consists of 7 full-time mechanics responsible for keeping our field equipment maintained and ready to be deployed.
- The Yard crew loads and unloads materials and equipment.
- The Lumber yard crew precuts all our project-specific formwork.
- The Expediting team arranges for our equipment to be shipped to and from our projects.

Field

Our field teams are led by 29 superintendents, 16 of which work in our Coatings and Restorations division. The remaining 13 superintendents build cylindrical, wrapped prestressed concrete tanks. All of these tanks have cast concrete floors with shotcreted walls. Many of our tank building superintendents are ACI-certified nozzlemen. They have worked in the shotcrete industry for over 20 years and have trained numerous nozzlemen over the years.

To give some perspective on the need for an efficient and well-trained field team, last fall we began one of our larger tank projects located in Nicholasville, KY. The project was scheduled for construction extending through the winter months, so we accelerated the project to get as much of the shotcrete applied as possible before the cold winter temperatures in northern Kentucky could set in. We had over 43,000 ft^2 (4000 m^2) of shotcreted vertical wall with an average thickness of 15.5 in. (400 mm). With this large area, and the amount of shotcrete required — over 2,500 yd^3 [1900 m^3]— our management team decided to explore the use of two separate shotcrete crews applying material simultaneously. To do this, there was a lot of pre-planning and coordination required. We assembled two fully outfitted shotcrete teams, each with a pump, air compressor, mobile platforms, certified nozzlemen, and finishing team members. The request was made to the concrete plant to furnish our project with 200 to 250 yd^3 (150 to 190 m^3) per day with 10-yd^3 (7.6 m^3) trucks spaced approximately 20 minutes apart to ensure fresh materials for application. Constant communication with the batch plant was required to adjust the batching and subsequent delivery times as needed.

This project was larger than most of our standard projects, but with the vision to see the project through to completion as a result of our abilities as a “High Quality, High Production” construction company, we were able to substantially shorten our time onsite. The project still lasted through the winter months, but by accelerating the shotcrete process, we were able to complete the bulk of the shotcrete quicker and move on to forming and casting the dome roof before the bitter cold set in. This gave us more options to stay productive while working inside the tank. This is only one example of the way we approach every project by asking the question: what can we do to improve our quality and production?

Fig. 4: Nicholasville, KY

Fig. 5: Nicholasville, KY

Equipment

The standard shotcrete operating equipment we use on our projects consists of the following:

- Minimum 600 CFM (17 m^3/min) air compressor
- Schwing SP 750-15 pump
- 300 – 400 heavy duty concrete pipe and hose (3 in., 2-1/2 in. & 2 in. [75 mm, 63 mm, 50 mm]) with 2 in. HD nozzle body
- Kawasaki KX 60 front end loader
- Mobile arial platform

Fig. 6: Equipment - Nicholasville, KY

Routinely, daily equipment maintenance in the field is performed by our field crews. When projects end, we try to rotate our equipment through our shop in Gainesville where our staff of seven full-time mechanics reside; they maintain, service, and prepare our equipment for next project. Without quality maintenance of the equipment, breakdowns will put a costly halt to production.

Nozzlemen

We currently have 28 ACI-certified shotcrete nozzlemen, and all are certified for wet-mix in a vertical orientation. We have two that are also certified for dry-mix vertical, one that is also dry-mix overhead certified. All our project documents include the following phrase: “all shotcrete applied by or under the direct supervision of an ACI-certified Nozzleman.” This is an important detail in our industry. Over the 70 years that we have been in business, we have spent a great deal

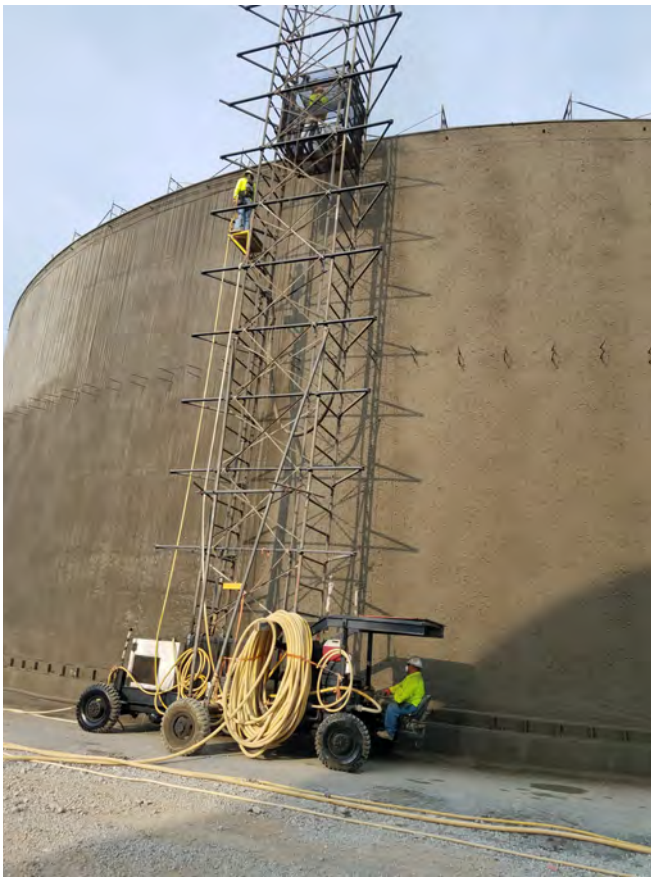


Fig. 7: Equipment - Nicholasville, KY

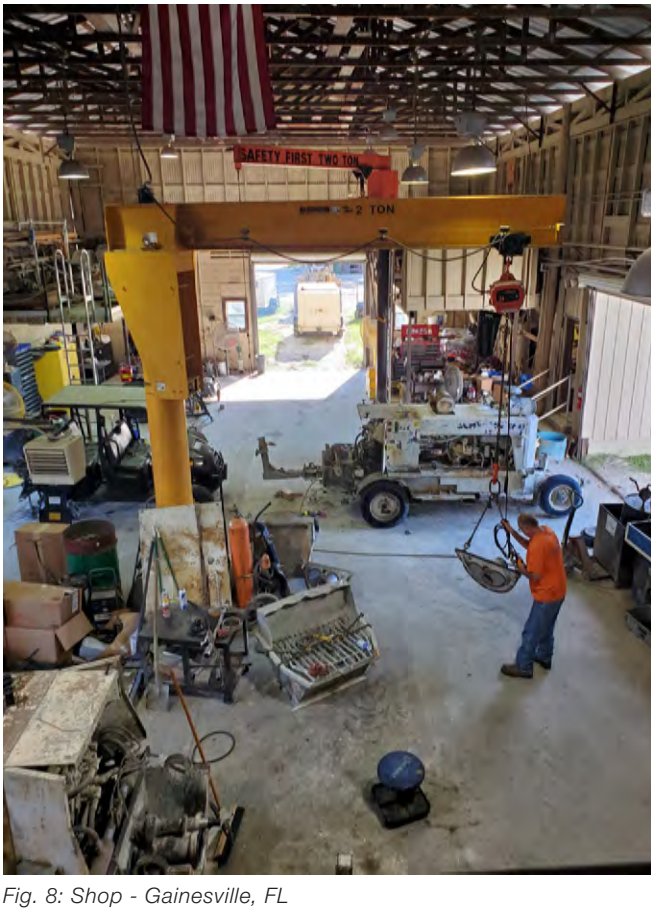


Fig. 8: Shop - Gainesville, FL

of time getting this added to project specifications to ensure only qualified shotcrete contractors are competing for the work.

All of our nozzlemen began their careers as laborers learning while working alongside our more experienced, skilled employees. The first step to becoming a nozzleman is learning the process. They start out dragging hose, shoveling rebound, running the gun, operating the pump, and, back in the day, busting bags on a "Gunite rig." It is very important that the nozzlemen have a detailed understanding of every aspect of the shotcrete operation.

After they master these skills and show interest in learning how to become a nozzleman, the real training begins. They are taught the importance of surface preparation. These are just a few of the countless items our certified nozzlemen always check for before starting the shotcrete application:

- Has all laitance been removed?
- Is the surface clean?
- Is the formwork stable?
- Is the steel reinforcing properly placed and secured?

They learn the importance of "impact velocity" to ensure that reinforcing bars are properly encased. The way encasing steel was explained to me was that "the nozzleman is the last person to ever see that steel before it is going to be encased forever if it is encased properly." Without the proper impact velocity, the material will build up on the surface of the reinforcing bars instead of flowing around and encasing them, which will cause voids left behind the bars.

Fig. 9: Nozzlemen - Nicholasville, KY

Only with time, and working under the direct supervision of certified nozzlemen, will new nozzlemen develop the skills that will become second nature to them. When approaching their projects, they will recognize potential problems with the shotcrete placement, such as protrusions, corners, and any areas that may allow overspray or rebound to build up. These issues need to be addressed before beginning the shotcrete placement, which often means they need to stop

Fig. 10: Nozzlemen - Nicholasville, KY

Fig. 11: Nozzlemen - Nicholasville, KY

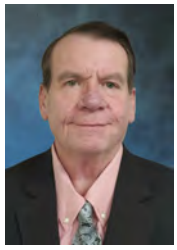
and clean. Other considerations include identifying whether the area is properly dampened to a surface saturated dry (SSD) condition. If not, the nozzleman must stop and get it properly prepped.

The hardest thing a new nozzleman has to learn about productive shotcrete application is that there is no substitute for quality; the areas that will be shot must first be prepared and then finished properly after shotcrete placement.

At the end of the day, the nozzleman is responsible for checking with the other team members to ensure that the shotcrete has been finished correctly and that proper curing has begun. They must also check to be sure that test samples have been stored in a safe place to avoid possible damage.

Summary

A high-production shotcrete operation, when operating at maximum efficiency, looks very organized and can appear to be easy. This is far from the reality. There are countless hours spent teaching and training all the team members on their assigned tasks. The efficient construction by the field teams is dependent on the team members that make up the support staff at the office and shop. It takes every individual performing their assigned tasks to produce the quality product we see in the field.



Bruce Russell *is the Field Operations Director for CROM. He has been involved in the construction of ground water storage tanks ranging from 100,000 gallons to 10,000,000 gallons in the water and wastewater industries since 1984. In 1987, he became a dry-mix "CROM Certified Nozzleman" under the strict performance standards that Ted Crom (founder of CROM in 1953) created, and which he insisted on for all nozzleman to ensure quality shotcrete application. In 2004, Bruce became ACI Certified in wet-mix and remains certified today. In 2014, he took over CROM's nozzleman certification/re-certification program. He serves on the ASA Board of Directors, on the ASA Contractor Qualification Committee, and on the ASA Safety Committee.*