Shotcrete Systems

By Brian Lywandowsky

My name is Brian Lywandowsky and I work for a large concrete construction company in the San Francisco Bay Area. I've worked in the concrete pumping business since I was sixteen. Since then, I have owned a small pumping business with my father and in 2007, I moved onto the company where I work today. I currently manage the Concrete Pumping and Lightweight Cellular Concrete divisions.

In my years as an owner-operator of boom and line pumps, I had some experience with shotcrete, with the majority of it being in the pool industry. Most of the shotcrete work I witness now is commercial work in the Bay Area and Northern California that consists of perimeter walls in subterranean parking garages, large shear walls, columns, retaining walls, sculpted walls, and repairs on bridges, just to name a few.

After spending time with the shotcrete crews in the field, I was able to learn more about the industry from a different point of view than just the pumping side of the business. I was very impressed with how well the shotcrete crews would perform their jobs on a day-to-day basis. The crews would often arrive on a job that was not set up or properly prepared. Many times, they needed to set up the delivery line comprised of steel pipe and rubber hose using unique techniques and with a limited amount of time. Once the job was set up and they could begin shooting, the crew would face less than ideal conditions, such as improper tied reinforcing bars, inadequately supported forms, and other obstacles. This made it tough to shoot properly, not to mention having to remove rebound from the work area to a designated disposal location. However, the crews would just put their heads down and go to work, producing a fantastic end product.

The shotcrete crews have also done a great job understanding what it takes to get the most out of the pumping equipment. They've figured out that using steel pipe on any pour that required more than 100 ft (30 m) of delivery line would keep pumping pressures to a minimum, create less breakdowns of the equipment, and help get more volume of concrete placed per hour. Using steel pipe from the back of the pump and limiting the rubber hose is a huge help to the overall daily production. It also helps eliminate premature wear of the outside of the rubber hoses caused by the sliding or sawing action produced by long runs and high line pressure in a rubber-only delivery system.

Using the concepts I learned while owning and operating concrete boom pumps, my experience could help crews optimize the set up and cleanup of the pumping system portions of the job. When starting a new project with difficult conditions, we now show up with a truck either a day or two before the job begins with all the necessary pumping components. We'll go ahead and install the delivery system so we are ready to shotcrete on shoot day. We designed specialized mobile parts that clamp to solider beams, standpipe 90-degree elbows, and brackets that can be bolted or welded to the existing buildings or structures.

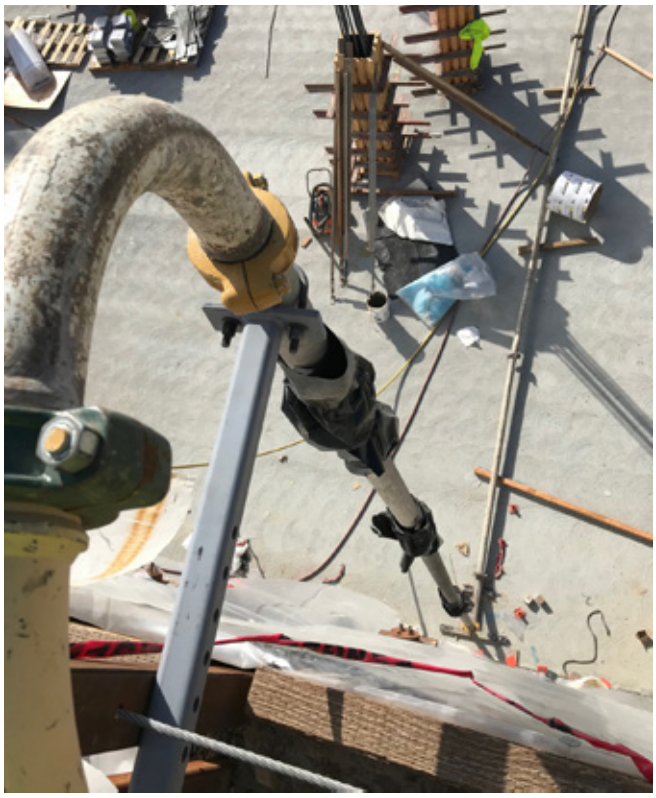

Fig. 1: Long vertical run of shotcrete line, "a shotcrete standpipe"

COMPRESSED AIR METHOD

When on the job, I've seen many crews cleaning both rubber and steel delivery systems with compressed air. I believe this is the norm in the industry. The blowout process crews used had likely evolved over time after many near misses and hose whippings. Crews would start by using air with no type of dart or plug to force the concrete out of the system. This would serve to limit, but not prevent, the amount of hose whippings at the end of

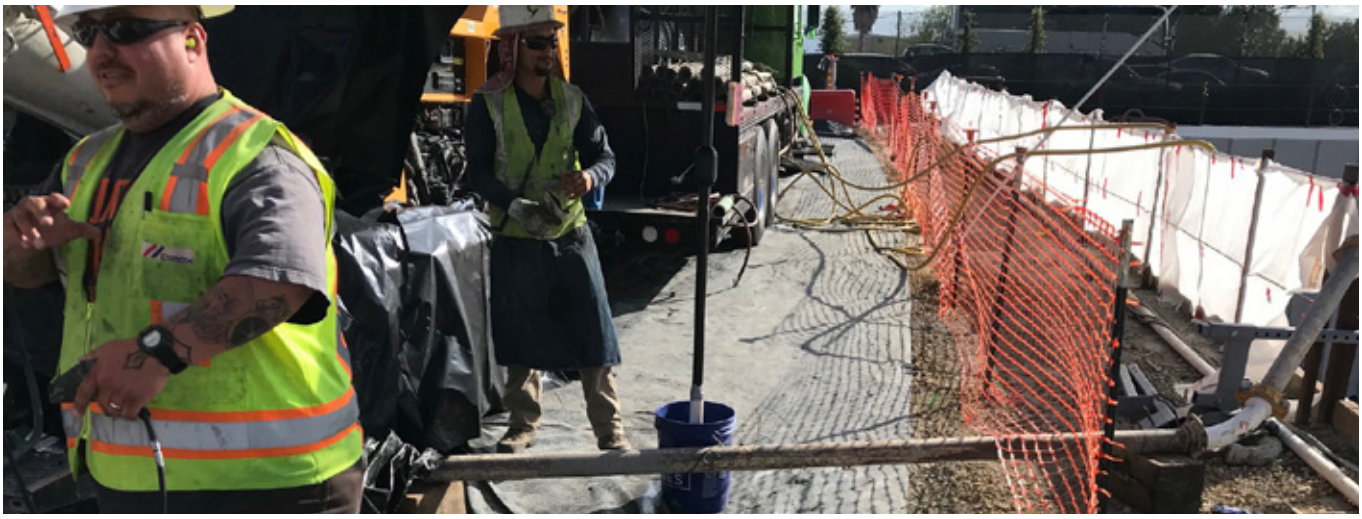

Fig. 2: Steel delivery line exiting pump

the line caused by the compressed air moving through the line. The pump operator would unhook the system from the pump and then use a blowout cap to push air through the system, starting at the pump and blowing the concrete out the end of the hose. Typically, the largest guy on the crew would try to control the hose end as the air was being applied to the delivery line being cleaned out. He would hold the hose for dear life and get a series of small but somewhat controlled explosions of concrete at the end of the rubber hose. This went on until more air than concrete was being expelled from the end hose indicating the majority of the concrete was cleared out of the system.

In the next step, the pump operator removed the blowout cap and placed a small sponge in the line and reattached the blowout cap to the pump end of the hose. Once again, the man on the discharge end would kneel on the ground with the hose running between his legs or alternately trying to tie down the hose in some way. He would then signal the operator to start the air flow and hold on with a grip that was second to none. By leaving a minimal amount of the concrete in the system, it becomes much more difficult to be able to judge where the sponge is within the system and how fast it is traveling. As it travels closer to the end hose, it can create hose whipping.

The use of compressed air to clear concrete from the system is extremely dangerous. However, with the proper training and correct parts, this process can be safe, fast, and clean. The American Concrete Pumping Association (ACPA) has created rules for cleaning pipes with compressed air, that I believe need to be implemented into the American Shotcrete Association (ASA) safety guidelines. The shotcrete system is different from placing boom type work when it comes to using diverter valves and designated pumping stations. While shotcrete locations typically change from day to day and are not typically using a diverter valve, the rest of the ACPA rules still apply.

Be extremely careful when using compressed air to clean out the placing line.

1. Cleaning with air requires two trained people.
2. No person is allowed to be near the discharge end of delivery line.
3. A dart catcher must be used and the outlet must be controlled.
4. A proper blowout cap must be used.
5. The discharge end of the delivery line should be in a position to permit easy discharge of concrete.
6. The dart or plug used must not be able to let compressed air pass by and into the concrete.
7. No rubber hose can be cleaned with air unless using an attachment specifically used for clean-out into a designated box or mixer truck.
8. Work on the delivery line is allowed only after line has been relieved of compressed air.
9. A good, reliable method of communication between the operator and crew at the end of the delivery line is needed.
10. All PPE must be worn when cleaning out the delivery line, including gloves, safety goggles, ear plugs, respirator, long sleeve shirt, work boots, and vest.

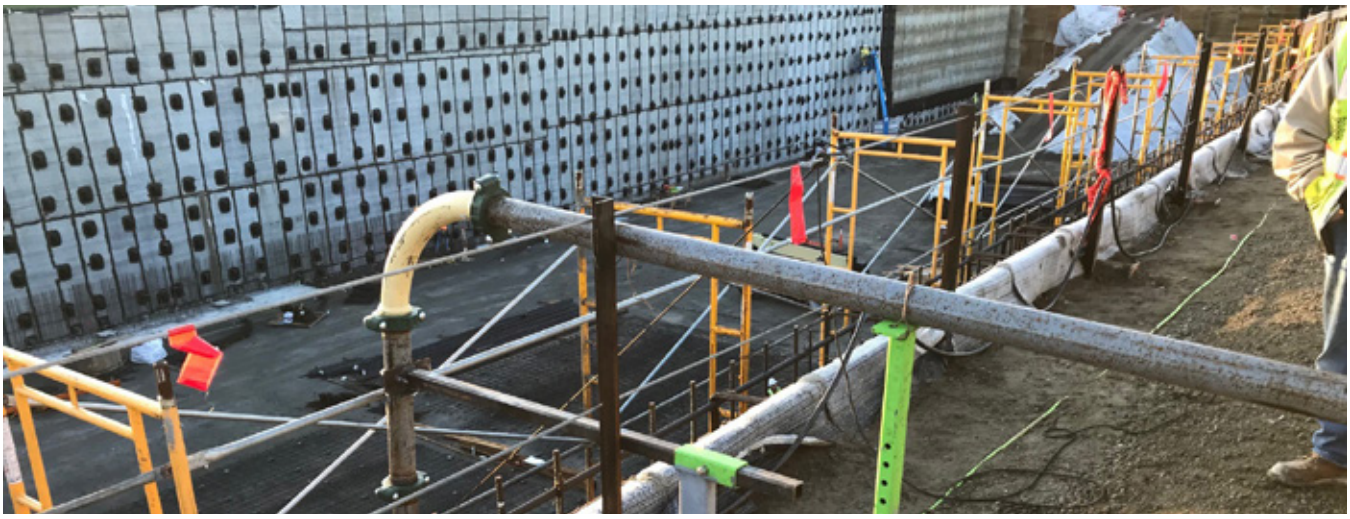

Fig. 3: Shotcrete standpipe clamp and support

Compressed air can only be used to clean out a steel delivery line. It must never be used on rubber hose as the hose whipping effect at the discharge end can be extremely dangerous. When using compressed air, one must be able to control and catch the object that is used to clear the line. It is also very important to only have trained people doing the cleanout. A blowout cap must have the proper distance between the air inlet and dump valve. The catcher must be properly sized to not allow the dart to escape but allow the exiting concrete to easily flow through it. A proper plug or dart must be used to push concrete and it must not let air bypass directly into the concrete. Allowing air to bypass can create a blockage by separating the concrete.

When the shotcrete placement is finished, the trained crew members will remove the rubber hose and connect a dart catcher to the end of the steel line. Once this is done, the operator will breach the line at the pump and insert a rubber dart on the pump end of the line. The operator and designated crew member must be able to communicate, generally by radio. The pump operator will begin to insert air into the delivery line and once concrete begins to move, he will begin to control the amount of air being added to the system. As the concrete begins to move and clear the line, it will take less pressure to move the concrete. The existing air in the system will begin to decompress, accelerating the plug or dart. It is important to feather the air into the system and open the dump valve at the blowout cap to relieve air and keep a slow and steady flow through the delivery line. It is important to have a trained crew member communicate with the operator when the dart is speeding up, and how close the dart is from exiting the system to keep a controlled blowout.

Cleaning the rubber hose can be done very easily by using a garden hose with 50 psi of water pressure. Once the rubber hose has been disconnected from the steel delivery line, a clump of wet paper is forced into the hose. A water cap is clamped onto the hose and a standard water hose is hooked up and used to clear the concrete from the hose. The hose is cleared when the paper exits the other end of the hose.

WATER WASHOUT

The water washout is by far the safest and most practical means to clean both the steel and rubber delivery lines. By using water, one has a material that doesn't compress and have the potential for an explosive discharge that has unfortunately become the norm in the shotcrete industry.

Water cleanout only works when one has access to a good water supply from a high flow water source such as a fire hydrant, water buffalo, or water truck. At the end of the shooting, the operator cleans the hopper and valve by doing a quick washout of the pump and inserts a plug or dart into the delivery line at the back of the pump. They should then fill the hopper and, once full, begin to pump water through the system until the plug or dart is pumped out of the end of the system. The water method is far safer than using compressed air because it eliminates the potential for violent hose whippings. Concrete pumps are capable of producing

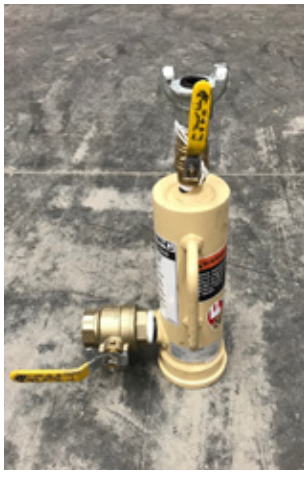

Fig. 4: Blowout cap

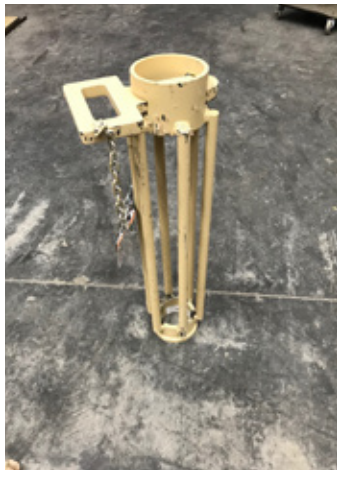

Fig. 5: Dart catcher

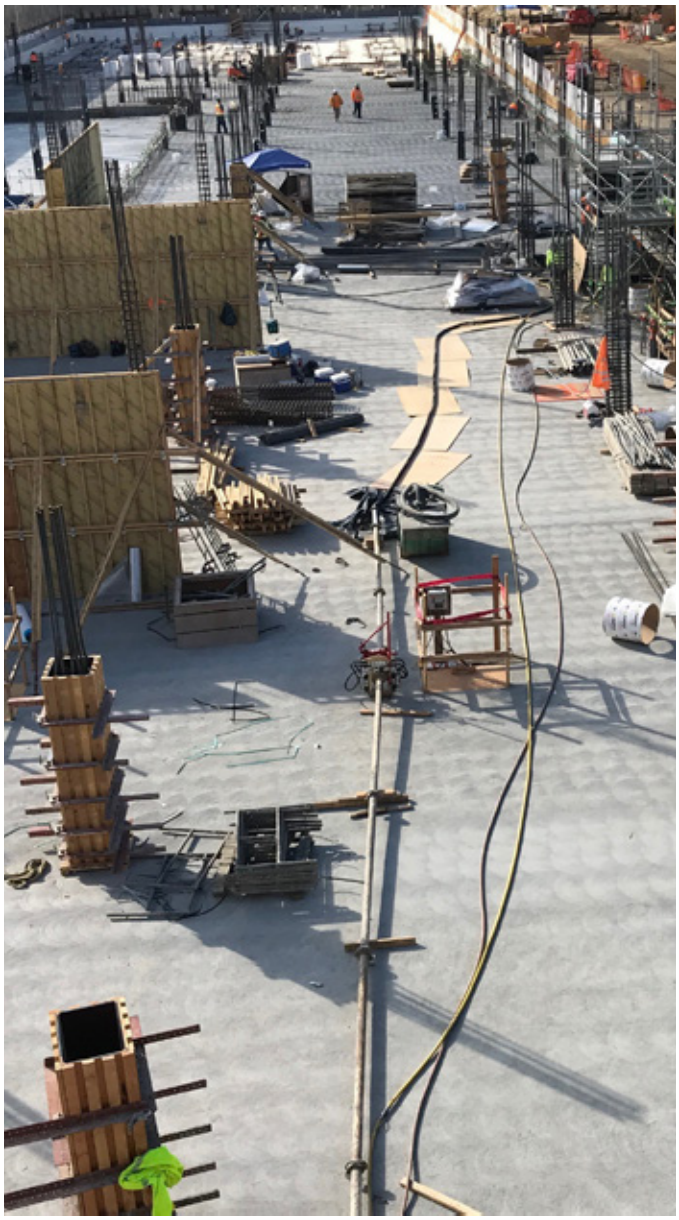

Fig. 6: Steel line transitioning into rubber hose for final discharge

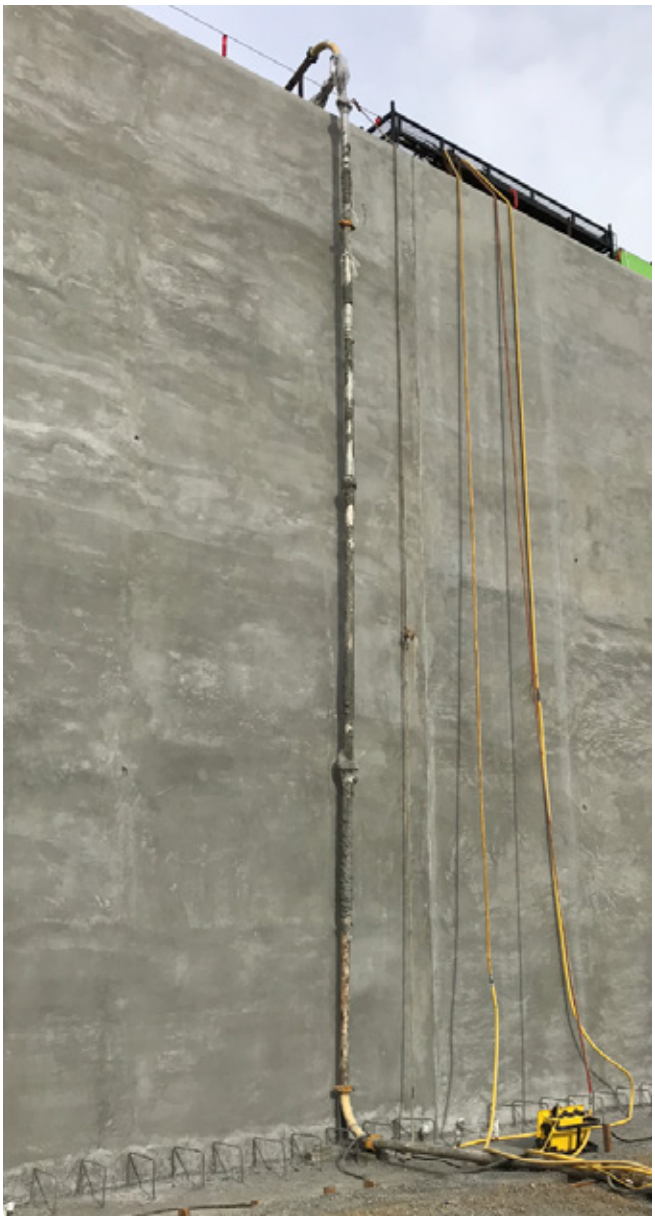

Fig. 7: Shotcrete standpipe

much greater line pressure than even high-pressure air compressors. However, the challenges are often the availability of water and a place to put the water once the system has been cleared.

SUMMARY

Either one of these cleanout processes when properly executed will decrease cleanup time, create a cleaner steel and rubber system, and make priming the system for the next day's shooting much more successful. The safety aspect is the most important consideration for using proper techniques in the cleaning of the delivery line. Using trained crew members and proven techniques will keep everybody safe and give them the best possible process so they can safely and efficiently place shotcrete each and every day they go to work.

Brian Lywandowsky *has been in the concrete pumping business for 31 years. He started out as a partner at Eagle Concrete Pumping with his parents. The business was small and started out with two ball valve pea gravel pumps then steadily grew the company into a fleet of five boom pumps and four-line pumps. In 2007, Lywandowsky sold Eagle Concrete Pumping to The Conco Companies and went to work for Conco as an Area Manager in Redding, CA. After seven years with Conco in Redding, Lywandowsky made the move to the Bay Area and has worked his way to now managing the Northern California pumping operation. In addition to concrete pumping, Lywandowsky provides support and leadership in the development and production of a new Lightweight Cellular Concrete operation known as Con-Foam along with his work in Conco's shotcrete business.*