

The Value of Shotcrete Accessories

by Patrick Bridger

I am frequently asked by contractors to aid in the selection of shotcrete equipment and accessories for many types of shotcrete applications, both wet-mix and dry-mix processes, including concrete repair and restoration, pool construction, mining, tunneling, soil nailing, slope stabilization, and refractory applications.

There are many choices of equipment and accessories for shotcrete contractors today. Various types of equipment include concrete pumps, gunite (dry-mix shotcrete) machines, mixers, and predampeners. There are many more types of ancillary equipment and accessories that go along with the primary shotcrete equipment used today. Let's take a look at some of these other tools used to apply shotcrete and why they are important.

Dry-Mix Guns

I'll begin with the dry-mix method. The purpose of a gunite machine is to meter material continuously in a hose, using compressed air to transport the material through the hose, with water added to the material at the nozzle. There are three types of gunite machines commonly used today—the pressure vessel, rotary gun, and rotary bowl. Each type of machine has its place in the market, depending on the type of job to be done. But what else do you need to properly apply dry-mix shotcrete?

Materials Supply

Today, much of the material used in the dry-mix method comes in a bag. These bagged materials have something in common. They contain dried aggregate and binder (cement). There is no moisture present in these materials, or if there was, you would have a bag of prehydrated hard material.

Predampeners

A predampening device or machine is one of the most important elements in a dry-mix application. It is, however, often one of the most overlooked. The primary excuses that I have heard for not using a predampening device are price and availability of such machines, and material manufacturers do not insist on the use of such equipment. The cost of a predampener can pay for itself in a relatively short time. Benefits of predampening include better in-place uniformity of the applied shotcrete, greatly reducing dust at the machine as well as the point of placement, greatly reducing rebound (saving material costs and labor costs to

dispose of rebound), decreasing wear on equipment, and eliminating static shock (some of you know what I'm talking about)! Most predampeners are simple mechanical devices with a feed hopper and conveying screw, discharging into a trough with mixing auger and water nozzles. A precise amount of water is added in the mixing trough, and then material is conveyed up and discharged into the hopper of the gunite machine. If you are applying dry-mix shotcrete and don't own a predampener, consider this as a sound investment in your company. Predampening should be a must for all dry-mix shotcrete applications.

Dry-Mix Nozzles

Let's take a look at the other end of the hose—the nozzle. The purpose of the nozzle is to complete the wetting of the material (or completely wet the material if not predampened). The wetting is done with a water ring that injects water into the stream of material and air. There are several nozzle configurations and sizes to choose from. It is important that the holes in the water ring remain open. If one or several holes become plugged, the material will not be uniformly wetted as it strikes the substrate, resulting in layering or "sand lensing." The nozzle tip provides mixing, spray pattern, and increased velocity. Common tips include the Hamm style, Double-bubble, or Spirolet. The water valve on the nozzle is usually a gate or globe valve with a cast metal handle. The valves are usually sufficient to meter the water correctly, but the handles can break. Experienced nozzle men usually prefer a needle or diaphragm valve because they are more precise in controlling water addition and will hold up better in extreme conditions.

Hydro-mix nozzles are very much the same as regular dry-mix nozzles. They have the same components, but the difference is that the nozzle body and water ring are set back a distance from the nozzle tip. The distance can vary from 1 to 10 ft (0.3 to 3 m) back in the line. A hydro-mix nozzle does not provide the same results as predampening. It does, however, allow the material and water to tumble in the hose captive for a fraction of a second longer before passing through the nozzle tip and onto the substrate for more uniform mixing.

Water Pressure Booster Pumps

Water pressure is a must for all dry-mix shotcrete jobs. Typical water pressure ranges from 40 to 60 psi (0.3 to 0.4 MPa) from most city water supplies.

That simply isn't enough water pressure for the water to pass through the water ring and overcome the back pressure in the gunite hose. There are many water pressure booster pumps available, and some work better than others. Consider a water pump that provides a minimum of 15 psi (0.1 MPa) greater than back-pressure in the hose. Minimum water pressure to consider starts around 80 psi (0.5 MPa) up to several hundred psi. Air and electric powered pumps are most common. Some types of electric water pumps require that water is steadily moving through the line or the motor will burn up. They require special plumbing or the pump needs to be turned on/off to prevent pump failure. There are water pressure booster pumps that are user friendly to the start/stop demands of a gunite job.

Dry-Mix Hoses

There are a couple of different types of material hose and hardware that are common to the gunite business. There are two types of material hose—natural gum rubber and synthetic butyl rubber (SBR). Natural gum rubber hose is the most flexible and abrasion resistant. SBR is stiffer and usually costs less. It also doesn't last as long. SBR hose, however, is static dissipating. Natural gum rubber has ground wires built in the carcass. These wires must be connected from each section of the hose through the couplings back to the gun. If not, you can be subjected to a very uncomfortable jolt of static electricity. Remember, static shock will be eliminated when you predampen the material being used! Hose wears from the inside out. Use care laying out the hose during use, avoiding sharp bends or kinks. Never store hose outside in direct sunlight, as this will deteriorate the hose rapidly.

Dry-mix shotcrete material hose is connected with external couplings. Couplings are usually made of brass, aluminum, or steel. Some are threaded and some require Victaulic clamps. I prefer the flanged ends with Victaulic clamps. Tools such as hammers or wrenches are not necessary to connect hoses. Threaded couplings can easily get damaged or become encrusted with shotcrete, making it difficult to set up the system, so housekeeping is important.

An air hose is also necessary to a gunite job. Make certain that the air hose is free from damage and the couplings are installed correctly. Remember to perform whip checks on all air hoses, and to use safety pins in Chicago couplings. Have extra gaskets on hand for air and water hoses.

Gunite Box

Lastly, every job needs a gunite box. The gunite box should have spare parts for everything that could possibly shut down a job. It should include plenty of spare gun parts, nozzles, hoses, gaskets, tools, fittings, etc. Other construction tools like shovels,

wheelbarrows, brooms, and finishing tools like trowels, floats, fresnos, and cutting rods should also be on hand. Be sure you also have a First Aid kit.

Wet-Mix Shotcrete

Wet-mix process shotcrete jobs are a bit different. The primary equipment for wet-mix shotcrete is a pump, air compressor, and freshly mixed concrete material. Shotcrete pumps use high pressure to get the shotcrete through the line. The hoses and pipeline are designed to withstand these extreme conditions of high pressure and abrasion.

Wet-Mix Hoses

The shotcrete system is made up of reducers, clamps, hoses, pipeline, bends, etc. to convey the shotcrete from the outlet of the pump to the nozzle. For hand spraying, 1-1/2 and 2 in. (38 and 50 mm) systems are most common. There are a couple of types of ends for wet-mix shotcrete hose—grooved, heavy-duty, and a new flanged type. If you are just starting out, buy heavy-duty. It is much safer than grooved ends. If you are currently using grooved ends, phase them out and convert the system to heavy-duty or flanged ends. Some people still use grooved ends because the coupling joints are smaller and weigh less. With the new flanged coupling, you can use your smaller grooved clamps (Victaulic), but replace the soft gasket with a specially-designed



Model PD-1 Predampener



Air-powered water booster pump



Peristaltic-type dosing pumps

hard gasket and the flanged ends on the hose. The flange system gives you the best of both worlds—smaller, lighter coupling joints with a high-pressure, safer coupling.

Use steel pipeline as much as possible. It is easier to pump through steel pipeline than rubber hose. Some people like to reduce all the way at the pump outlet; others will reduce slightly at the outlet, and do the final reduction near the nozzle section. No matter how you do it, always inspect this system for wear, damage, or concrete build-up. Always use safety pins in clamps.

Wet-Mix Nozzles

A wet-mix shotcrete nozzle is slightly different than a dry-mix (gunite) nozzle. Instead of injecting water at the nozzle, air is injected. The nozzle should allow enough air volume to break up the solid slug of shotcrete into nearly individual particles, similar to gunite. The nozzle tip is also tapered smaller than the hose size, further increasing the velocity and providing a good spray pattern. There are some very poor nozzles out there. Find one that performs well.

Wet-Mix Pumps

There are a few pump options worth mentioning. All pump manufacturers equip their machines with a hopper grate for safety reasons. But for shotcrete, the grate should be designed to sift out rock and other large debris that can come out of concrete mixers. With grate bars spaced closer to catch the larger material, it can be difficult to get the shotcrete through the grate. A grate equipped with a vibrator, either air or electric powered, and rubber shock mounts can help overcome this problem.

Another pump option that is a must is an auto-lube system. And pump mounted pressure washers are convenient for cleaning your pump. These two

options increase the life of the pump. Ninety percent of the maintenance on the pump is cleaning and lubricating every day. Other pump options are remote controls, either corded or wireless. Exhaust scrubbers should be used in poorly ventilated spaces.

Accelerator Pumps

Shotcrete accelerators are being used more frequently. Liquid accelerator needs to be injected at or near the nozzle. Using liquid accelerator requires a dosing pump. There are different types of liquid accelerators and different types of dosing pumps. Examples include pressure vessels, piston/diaphragm pumps, moyno (rotor/stator), and peristaltic pumps. The newest advances in equipment technology enable the dosing pump to be synchronized with the shotcrete pump. It is state of the art technology for hand or robotic application.

Tool Box

A tool box should also be carried to a shotcrete job. It should include spare clamps, gaskets, sponge balls (for cleaning the system), clean out cap, nozzle, nozzle tips, cleaning brushes, fittings, etc. Personal protective equipment such as safety glasses, respirators, gloves, harnesses, and boots are required; and don't forget the First Aid kit.

Always be prepared for the unexpected. You can never have enough tools in the tool box on any shotcrete job.



Patrick Bridger is the Sales Manager for Allentown Equipment. He has been involved in the shotcrete business for over 20 years, beginning at Shotcrete Plus, Inc., an equipment manufacturer. Four years

later, Bridger joined Southern Refractories, Inc., a refractory shotcrete contracting firm as Operations Manager. In the 10 years spent as a contractor, he was involved in numerous projects throughout the country. In 1997, he joined Allentown Equipment as manager of Concrete Repair. In 2000, Bridger assumed the responsibility of Sales Manager, looking over all markets including concrete repair, refractory, and underground. He is a member of ACI Committees 506, Shotcreting, and C 660, Shotcrete Nozzleman Certification, and has been the Secretary for the American Shotcrete Association since 2002, as well as Chair of the Membership Committee. Bridger is also an approved trainer and examiner for the ACI Shotcrete Nozzleman Certification Program.