

## A Closer Look at the Benefits of Predampening

By Todd Ferguson

**M**uch has been written on the benefits of predampening dry-mix shotcrete (gunite) materials before application; however, it is worth exploring these benefits in greater detail. The purpose of predampening is to add moisture content to dry shotcrete materials to ensure benefits during and after the project. Predampening is used in a diverse set of industries, including ground stabilization, refractory relining, tunneling, mining reinforcement, and bridge applications, to name just a few. Virtually any dry-mix shotcrete project benefits from the use of predampening materials. It is the industry “best practice” as stated in the ACI 506R-05, “Guide to Shotcrete,” that “the crew should predampen the batch before introducing it to the shotcrete delivery equipment.”<sup>1</sup>

### Dry-Mix Shotcrete (Gunite) Materials

Dry-mix shotcrete is either pre-bagged, delivered by truck, or batched on-site. Available in a

wide range of specifications, pre-bagged materials contain a binder cement, sand, some level of aggregates, as well as other additives, which are normally proprietary to their manufacturers. Otherwise stated, “dry, pre-mixed shotcrete consists of pre-blended aggregates (rock and sand) that are pre-dried to minimal moisture and mixed with accurate amounts of silica fume, set accelerator, steel fibers, and any other addition required.”<sup>2</sup> Obviously, not all materials contain the same additives and only some contain steel fibers. Packaged dry shotcrete materials are devoid of moisture by design—they have undergone a drying treatment in their manufacturing so that they could be packaged. Premixed dry shotcrete materials offer inherent benefits of long shelf lives, consistent specifications, engineered production standards, and high early compressive strength and long-term compressive strength. Other materials used in dry-mix shotcrete may be delivered by ready mix or batched on-site with bulk sand and cement from bags or other storage containers.

### Predampeners

The predampener is machinery consisting of a material hopper for loading pre-bagged materials and a combination auger/spray bar system that transfers materials as they are lightly misted with a water spray. The predampener’s auger system allows this predampened material to fall into the receiving hopper of a dry-mix shotcrete (gunite) machine. Contractors use predampeners to add 3 to 6% overall moisture content to dry-mix material before it is loaded into a dry-mix shotcrete machine. Batching and mixing equipment is also available for those producing materials on-site. This equipment performs a dual function of proportioning materials and predampening. Otherwise, the contractor will use a dedicated predampener or special hydromix nozzle to add moisture. Hydromix nozzles of various configurations have been used in the industry. The traditional hydromix nozzle contains a single nozzle



Fig. 1: Dry-mix shotcrete nozzleman using predampened materials during a parking garage repair

# Technical Tip

body, installed at a distance of 12 to 36 in. (300 to 900 mm) from the nozzle tip.

The benefits of predampening are worth exploring. Although predampening has been advised as a best practice by ACI and ASA, it would seem that until now we have yet to adequately correlate predampening benefits with the recommendations stated throughout ACI 506R. We will explore each benefit of predampening in the following, relating each to best practices while illustrating how they apply to safety.

## Benefits of Predampening

- Higher-quality in-place concrete;
- Reduced dust around equipment and nozzle;
- Reduced rebound;
- Less wear on equipment;
- Greatly decreased static electricity; and
- Higher return on investment.

## Higher-Quality in-Place Concrete

Predampening in the dry-mix shotcrete process helps ensure uniformity<sup>3</sup> of in-place shotcrete, elevating the quality of the concrete structure. Uniformity can be seen in various stages of shotcrete production, both before and after materials are shot onto the surface. Before even reaching the nozzle, materials that are predampened will have better mixing and uniformity. Predampening reduces separation “of the dry aggregates and cement binders as the predampened material moves through the hose, which will result in a better finished product in place. Also, the dampened material accepts the water better when the entire amount does not have to be introduced at the nozzle.”<sup>4</sup> Predampening leads to better uniformity of the in-place shotcrete because the material has started to mix before even reaching the nozzle. The material then undergoes additional mixing within the nozzle and is conveyed onto the construction surface. Predampened materials lead to consistent distribution throughout, giving a “more homogeneous moisture content to the in-place shotcrete.”<sup>2</sup> A more homogenous material allows a less-variable, more evenly distributed strength in the resulting concrete. When the shotcrete project results in more structurally sound concrete, the risk of failure is minimized. This guarantees a safer environment for everyone who lives, works, and plays on that concrete structure.

## Reduced Dust around Equipment and Nozzle

Health and safety of the crew is a priority. Predampening reduces dust, which limits workers’



Fig. 2: Predampener shown with dry-mix shotcrete machine

exposure to materials containing cement, silica fume, and other chemicals not compatible with the human body. In enclosed spaces such as refractories, tunnels, and mines where ventilation is minimal, dust could be a significant health concern. Dust is minimized at multiple points of the shotcrete operation when using a predampener, “greatly reducing dust at the machine as well as the point of placement.”<sup>3</sup> The dry-mix shotcrete machine contains a material agitator and rotating feed system, which may create dust if using dry material right out of the bag or “super sack.” Luckily, some dry-mix machines have suppression systems to help prevent excessive dust in these situations. The predampener is the most effective means of reducing dust around the machinery. That same dust “can contaminate adjacent structures, equipment, and grounds. This problem is especially aggravated on windy days.”<sup>1</sup> In addition to reducing dust around the machinery, predampening minimizes dust at the nozzle. More research is needed to determine just how much dust reduction can be expected at the nozzle.

## Reduced Rebound

Rebound is minimized in the dry-mix process by predampening. The benefit of reducing rebound can be realized by higher yields;—that is, less wasted material. Less rebound during the project also reduces labor time. “Rebound is aggregate and cement paste that ricochets off the surface during the application of shotcrete because of collision with the hard surface, reinforcement, or with the aggregate particles themselves. The

amount of rebound varies with the position of the work, nozzle angle, air pressure, impact velocity, cement content, water content, maximum size and gradation of aggregate, amount of reinforcement, and thickness of layer. A blowpipe is sometimes used to remove and control rebound.”<sup>1</sup> Because rebound primarily consists of aggregate, it should never be used in the structure. Instead, it must be removed either by shoveling, blow pipe, or other means. Less rebound means less labor time to remove it. Predampening reduces rebound by allowing the cement binders in the mixture to give a more adequate coating over the aggregates. These components will then remain more closely tied together with greater amounts of materials adhering to the shot surface. Excessive rebound can lead to undesirable shrinking and drying of the shotcrete, so it is important to keep it within acceptable limits. For example, an expected range of rebound losses on slopes and walls is 10 to 30%. By predampening, we can endeavor to achieve the highest yield of material used for in-place shotcrete while reducing labor and helping to create safer concrete structures.

## Less Wear on Equipment

Predampening dry-mix shotcrete materials makes them less abrasive and increases the life span of various components in the dry-mix equipment setup. These components are recognized as “wear parts” and are primarily part of the dry-mix shotcrete machine, hose, and placement nozzle. They include the feed system wear plate, wear pads, discharge liner, internal material hose lining, placement nozzle washers, and liner. The expected life span of these components is well-known and documented. However, it is not known to what extent the life span of these parts is improved when using predampened materials. More research is needed to determine how predampening affects the life span of these parts.

## Greatly Decreased Static Electricity

If dry-mix materials are conveyed with low moisture content, a static charge can build up in the hose and can give a shock to the nozzleman if using ungrounded delivery hose. Predampening can virtually eliminate this situation by adding the recommended 3 to 6% moisture content, which reduces the likelihood of static charges in the line. Static electricity building up in the system is not merely an annoyance to the nozzleman, it is a safety concern. The static electricity “can shock the nozzle operator and cause a loss of control of the nozzle.”<sup>1</sup> The most important safety

requirement for the nozzleman is that he retain control of the nozzle at all times, never pointing it in an unsafe direction and never setting it down while material or pressure are present in the lines. Decreasing static electricity through the use of predampening, the nozzleman will not be caught off guard by an electric shock, which could cause him to lose control of the nozzle. Any undue stress on the nozzleman could affect his performance and the overall quality of the shotcrete placement.

## Return on Investment

In addition to all of the benefits mentioned previously, predampening is a sound business decision! Predampening equipment can “pay for itself in a relatively short time.”<sup>3</sup> Better mixing and uniformity from predampening results in concrete that is more structurally safe and sound. Less dust keeps your crews in better health, potentially saving your business on health care premiums, not to mention the peace of mind you get by doing the right thing for your people. Reduced rebound allows you to get the most out of your material and improves your labor efficiency. Decreased wear on equipment may allow you to save on replacement parts for the dry-mix shotcrete machine and placement nozzle. Greatly reducing static electricity reinforces your commitment to safe working conditions. Predampening materials in the dry-mix process is not only a recommended procedure; it is also clearly a winning solution for quality, efficiency, safety, and profitability of your business.

## References

1. ACI Committee 506, “Guide to Shotcrete (ACI 506R-05),” American Concrete Institute, Farmington Hills, MI, 2005, 40 pp.
2. Armelin, H.; Duke, N.; and Contreras, J.M.L., “Dry, Pre-mixed Shotcrete Supply for Tunnels and Mines,” *Shotcrete*, V. 1, No. 3, Aug. 1999, pp. 8-11.
3. Bridger, P., “The Value of Shotcrete Accessories,” *Shotcrete*, V. 7, No. 3, Summer 2005, pp. 10-12.
4. Sofis, T.W., “Gunite Refractory Installations,” *Shotcrete*, V. 10, No. 2, Spring 2008, pp. 26-27.



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