Materials Handling Underground

By Craig McDonald and Julian Peña Cruz

Materials and equipment handling can be challenging in any industry. Movement of materials and equipment in an underground environment, however, has its own unique challenges. Once supplies arrive at the surface of the jobsite, they must be sent underground through a network of tunnels to the work site where the supplies are required. For some mines and tunnel projects, access underground is available by a ramp from the surface. For others, access to an underground worksite may only be available through a vertical shaft with an elevator or cage that travels from the surface to the various levels. In either case, the shaft or ramp usually becomes a literal bottleneck in the process of getting materials to the worksite.

Like all jobsites, each mine or tunnel project has its own unique challenges. Shallow mines with ramps from the surface have the ability to use bulk haulage equipment to transport shotcrete materials and equipment to the heading. In the case of wet-mix shotcrete supply, material is delivered in trans-mixers, which travel via the ramp to the worksite or heading. For dry-mix supply, bulk bins mounted on underground haulage vehicles can be used to transport bulk dry-mix shotcrete to the worksite (refer to Fig. 1).

Fig. 1: Bulk dry shotcrete hauler/sprayer

Most bulk haulage equipment designed for shotcrete or concrete can carry between 4 and 9 yd^3 (3 and 7 m^3) of material per load. The drum or bins are charged on the surface and driven underground via the ramp, where they are discharged and then returned to surface so the process can be repeated. This type of delivery method is reliable and efficient. However, many mines and tunnel projects do not have the luxury of being able to use it due to lack of ramp access.

Mines and tunneling projects serviced only by a shaft often use bulk bags or super sacks of preblended material to overcome shotcrete supply challenges. Bags containing 2200 to 3300 lb (1000 to 1500 kg) of material are shipped to the site on pallets, where they are stored until used. In most cases, the site is accessible by road and shotcrete materials can be delivered directly on flatbed trucks. In certain cases, however, extremely remote sites require a more challenging strategy. Some remote northern mines, for example, can only be accessed by "ice roads" made popular through the television show *Ice Road Truckers*. For other remote locations, the only economically viable solution is to transport the material by boat. In both of these cases, the dry-mix material should be packaged in heavy-duty bulk bags with the additional protection of an inner polyethylene barrier. This added protection will reduce the possibility of moisture (in the form of water or snow) from coming in contact with the dry shotcrete material and causing the mixture to hydrate prematurely.

When transporting shotcrete by boat, smaller volumes are best shipped in 20 ft (6 m) shipping containers, which generally hold a maximum of 53,000 lb (24,000 kg). For larger volumes, bulk bags can be directly loaded into the hull of a vessel dedicated specifically for shotcrete material transport (refer to Fig. 2).

Whether a remote mine site in the far north or a local tunneling project located a few miles (few km) from the production plant, preblended, ready-to-use bags of shotcrete must be stored on-site until the surface crews are required to transport the material underground to the shotcrete crew. Once the material is delivered to the worksite, the shotcrete crew will be able to begin the shotcrete

placement process. If a well-planned worksite strategy is in place with appropriate material handling equipment, excellent lighting, and a well-trained shotcrete crew, the only limiting production factor will be the capacity of the shotcrete placement equipment.

Some mines in northern Canada have had success supplying bulk preblended dry materials underground via the shaft and cage through the use of cassettes (removable bulk bins that can be interchanged on an underground haulage vehicle). These cassettes can be charged with preblended materials on the surface from a storage silo and sent underground via the cage. For a project with ramp access, an underground haulage vehicle (designed specifically for carrying the cassette) can off-load an empty cassette and reload a full cassette so the material can be hauled in bulk directly to the worksite. As is the case with delivery using bulk haulage equipment, the elimination of bulk bags and pallets is an obvious benefit for bulk haulage and cassette delivery.

For cassette delivery, the negatives are the capital costs of the cassettes and, of course, weight. Most cassettes will weigh 6600 to 11,000 lb (3000 to 5000 kg), which reduces the amount of shotcrete material that can be delivered per trip by that amount. By contrast, bags and pallets weigh very little.

The use of a slick-line or bore hole from surface to a location underground has become a popular option for transporting both dry- or wet-mix shotcrete on mining and tunneling projects. This option eliminates the costly use of ramp or cage time, eliminates the need for bags and pallets, and allows bulk delivery of wet- or dry-mix shotcrete in an efficient, timely manner. The biggest detractor from the use of slick line or bore hole delivery is the high capital cost related to the haulage equipment and the installation of a slick line or bore hole. Depending on depth, the cost of a lined bore hole or slick line can reach well into seven figures, making it impractical unless large volumes of shotcrete are anticipated for a long period of time. Mines with a long anticipated life that use shotcrete for primary ground support are excellent examples of situations that can financially justify the installation of a bore hole or slick line. For a mine that may possibly require possibly hundreds of thousands of cubic yards (cubic meters) of shotcrete during its operational life, the high initial investment can pay dividends over the life of the mine by reducing the use of the shaft time, ramp time, and worker power required to facilitate moving materials either in bags and pallets or cassettes.

All things considered, there is not one system that can be effective for all locations. All sites have their own unique requirements and challenges.

Fig. 2: Preblended dry shotcrete being loaded into a ship's hull

Ingenuity has brought us to the point where bins on the surface equipped with level sensors automatically refill underground silos and inform the supplier on their own. However, sometimes there is no substitute for keeping it simple and going back to—or staying with—the basics.

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