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TOP DOWN

Last December a mining company raise boring a deep shaft needed to accommodate for questionable ground. **Nicole Robinson** reports on a centrifugal sprayed concrete lining applied in one work day

WHEN IT COMES TO SPRAYED concrete lining, there is conventional dry-mix shotcrete (where water is added at the nozzle) or wet-mix shotcrete (where air is added at the nozzle to pneumatically convey the material to the receiving surface). Both technologies have long been used for lining horizontal pipes, culverts, and vertical shafts.

In a white paper published by Colorado-based Shotcrete Technologies, Inc., the authors explain these systems have generally worked well and provided high-quality lining. But they are not without their challenges, including maintenance in the robotic rig and the need to be regularly cleaning the

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shotcrete nozzle. So the company developed another option; a centrifugal, sprayed concrete spinner head system, which has been used in horizontal structures since about 2005. In June 2009, they deployed the first use of this technology in North America to line a 3.5m-diameter, 290m-deep raise-bore shaft at the New Afton copper-gold mine near Kamloops, British Columbia (owned by mining company New Gold).

For the wet-mix centrifugal sprayed concrete, instead of adding water at the nozzle as in dry-mix shotcrete, or air at the nozzle as in wet-mix shotcrete, the concrete mix is pumped to a spinning head, which spins at between 4,000 to 5,000 rpm. The concrete is then centrifugally sprayed onto the receiving surface at high impacting velocity.

This alternative has been used on pipe diameters ranging from 457mm to 2,438mm and lengths of the pipes ranged from 8.5m to 762m, as well as for lining a 2,744m long concrete sewer tunnel.

At the time, the New Gold mine demonstrated to the shotcrete company that centrifugal sprayed concrete technology, with appropriate rigging, can be used to line deep raise-bore shafts with high rates of productivity. Shafts could be completed in considerably less time than is achievable with robotically applied dry-mix, steel-fibre-reinforced shotcrete--10



Concrete and water hoses both laid out prior to lining the shaft



days versus about six weeks in this particular example.

In 1998 Pan American Silver acquired the La Colorada underground silver mine in Zacatecas, Mexico, in the Sierra Madre mountain range. An expansion of the mine, launched in 2014, will increase the mine's capacity from 1,250 tonnes per day to 1,800 tonnes per day by 2018.

Work is expected to be complete by 2017, and involves the construction of a new 600m-deep extraction shaft between two of the mines' main zones, with a capacity for hoisting ore and waste of 2,300 tonnes per day as well as serving as the main access to working areas for mine personnel, and additional underground development to extend the operation to deeper levels.

Pan America Silver was raise boring the 613m deep by 6m interior diameter shaft in Zacatecas last fall. Construction of the new shaft advanced smoothly through good ground

Above: Bars of light help provide a clear picture of the shaft

Below: Crews position the camera before lowering it into the shaft

conditions that allowed construction crews to complete 312m of the raise bore, according to Michael Steinmann, Pan American Silver's president.

The upper 210m was in questionable ground, so it was decided to raise a smaller 3m-diameter bore, to shotcrete the shaft and then excavate from the top down. Shotcrete Technologies used remote-controlled, centrifugal sprayed concrete to line the shaft in a day.

The day after the bore machine was removed crews lowered a camera down and marked where the 3-inch (76mm) shotcrete was need—a total of 240lf (73m) in various areas.

"At 11am we started lining a flash coat, top to bottom," says Kristian Loevlie, Shotcrete Technologies CEO. "We then lined 3 inches of shotcrete where needed and by 6pm, the same day, we had completed the shaft lining."

A total of 30 cubic metres was in place. The company made its culvert lining mix on site using local material and the on-site batch plant. "We used 900ft [274.32m] of hose in order to keep everything flowing smoothly," Loevlie adds.

There was no noticeable rebound and this structural shotcrete would reach 22MPa in 24 hours.

As of May concrete lining and steel installation has reached a depth of 165m for the new shaft, which is approximately 85 per cent complete and on schedule to reach its output goal for the end of 2017 

