FINALIST - 2018 PROJECT OF THE YEAR

SPECIAL PROJECTS CATEGORY

Goedehoop Collieries Block 7 Project

SOUTH AFRICA

SUBMITTED BY KRYTON INTERNATIONAL, INC.

Fig. 1: View from the top of the shaft during the site inspection. The extreme water ingress points are evident all the way down the ventilation shaft. The base of the ventilation shaft was filled with water for 35 years.

BACKGROUND

South Africa has a long history when it comes to mining. It is an industry that forms the backbone of the South African economy. The client of this project has been a key catalyst to help create a stronger, safer, healthier, and more sustainable South Africa since 1917.

One of the key requirements in mining is to ensure adequate ventilation in a mine, and provisions are made for suitable airways for the air to flow down the mine to the working areas. The primary ventilation system consists of an intake (downcasts) through which the fresh air passes to the mine workings, and an exhaust (or upcasts) where the air passes after having been ventilated. Any interference with the ventilation system would have an impact on operations and safety.

The Goedehoop Colliery Block 7 mine ventilation downcast shaft is approximately 200 ft (60 m) deep and was constructed in the 1980s. The shaft consists

Fig. 2: Major water penetration points were blasting masses of water 12 in (300 mm) wide across the 23 ft (7 m) diameter of the shaft. The extreme pressure of the water was causing damage to the shaft structure and made the repair a very dangerous project.

of a segmented ring liner arrangement with an interlocking joint connection between the different shaft segments. The shaft had experienced the ingress of water over the last 35 years with a notable increase in the last couple of years through the joint interface, posing potential unsafe conditions, flooding, and deterioration to the existing concrete shaft liner (Fig. 1). The excessive leakage was pumped out on a daily basis as part of a routine operation which was required for the normal running of the mine.

Over the years, the underground water levels increased, exacerbating the potential for significant leakage and flooding of the mining levels. Early in 2017, the underground build-up of water broke through the concrete ventilation shaft, allowing excessive water penetration into the mine, threatening the safety of the miners.

A solution to the excessive water penetration into the shaft (approximately 1850 gallons [7000 liters] per minute) was required. If the excessive water penetration solution failed, it was inevitable that the affected shafts woud close. The ingress pressure of the water was immense, shooting water torrents approximately 12 in (300 mm) wide across the 23 ft (7 m) diameter shaft (Fig. 2). Numerous water ingress points occur along the full depth of the shaft, with the primary water ingress area located between 62 and 82 ft (19 and 25 m) below ground level. Being a ventilation shaft, there was no access to these areas, which therefore required the manufacture and installation of elaborate custom-made access equipment for both personnel and equipment.

A solution to the ingress of water from the positive to negative path (from outside the shaft into the shaft opening) was required. In addition, there was no access to the positive side (being underground). Even after extensive panel tests by various contractors, none were able to apply a product that could withstand the immense negative pressure exerted by the water in the mine shaft.

After an in-depth site evaluation, it was noted that the mine was under approximately 65 ft (20 m) of water and the repair of a water penetration point at this level posed many difficulties and risks. Numerous tests were carried out to ascertain the best procedures to access the mine, to investigate the concrete damage below water level, and to confirm structural integrity and safety.

THE SOLUTION

The scope of work focused on the main water ingress points which were in urgent need of concrete repair, jointing, and surface waterproofing. It was critical that the entire structure be correctly rejuvenated, repaired and waterproofed using crystalline technology, which has a proven success record in similar case studies worldwide for the past 40 years.

The very first obstacle to overcome was access down the 23 ft (7 m) diameter shaft riddled with leaks. After numerous discussions and on-site tests, the appointed access company devised a cradle system to safely lower workers into the shaft (Fig. 3). The cradle also needed to be stabilized against the sides of the shaft to reduce movement for the work at hand.

The inspection and preparation of the site were imperative for this project. A borehole had to be sunk to the depth of the major water ingress and camera equipment sunk into the borehole to accurately investigate the ingress from the positive side. A scan of the concrete in the affected areas by ground penetrating radar (GPR) equipment was conducted to ensure that the safety and integrity of the structure was still intact.

Fig. 3: Access to the shaft was a huge safety and logistical concern. The access specialists were able to supply a custom-built cradle to lower workers into the shaft. This cradle was anchored to the sides of the shaft to ensure no movement during the high-pressure cleaning and sandblasting.

Fig. 4: Swelling waterstop being tested with shaft water vs tap water.

With information gathered by visuals, a swelling waterstop had to be introduced to the positive side to reduce the water flow to a manageable condition (Fig. 4 and 5). In order to prepare the site for the application of crystalline waterproofing products, the damaged sections of concrete had to be cleaned and prepared using dustless sandblasting and ultra-high pressure cleaning. Concrete cutting machines and chisels were used to chip chases along the entire length of all water ingress points, construction joints and cracks. Running water was stopped by the use of a rapid-setting hydraulic cement and a swelling waterstop (Fig. 6). Chased cold joints were filled with a repair grout (specially mixed dry-mix).

Fig. 5: The waterproofing specialists tested the swelling waterstop on the ingress points to ensure the waterstop would swell to its maximum capacity to alleviate water pressure to continue with the crystalline leak repair system.

Fig. 6: Using a rapid-setting hydraulic cement and a swelling waterstop, the waterproofing specialists were able to successfully contain the flow of water to a single access point, thus making the water more manageable.

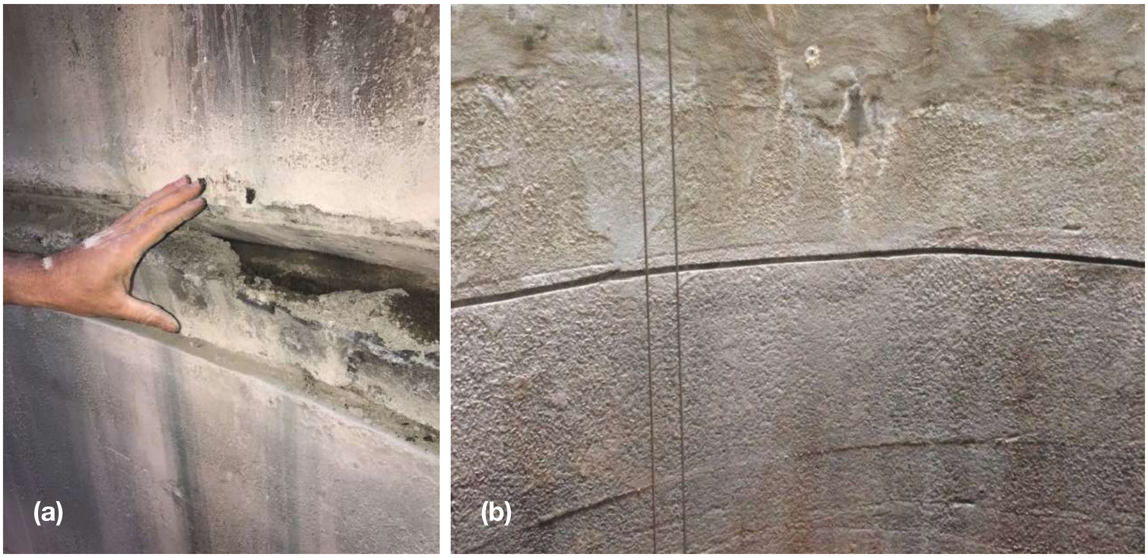

Fig. 7: After the water was fully contained using a rapid-setting hydraulic cement and a swelling waterstop, the surface area was prepared and a crystalline repair grout (a) and crystalline surface waterproofing (b) applied.

Fig. 8: View from the bottom of the shaft once the project was complete

Fig. 9: The base of the shaft had not been seen or dry for over 35 years. This was the first time that workers were able to stand at the base of the shaft.

Waterproofing crystalline surface-applied cementitious concrete compounds were applied to the surface in a slurry form in accordance with manufacturer's specifications (Fig. 7). The application over the entire surface of the concrete structure resulted in the growth of crystals throughout the concrete mass preventing any further water or air ingress into the concrete, thus transforming the concrete itself into a waterproof barrier.

The growth of these crystals into the concrete and subsequent waterproofing of the concrete will retard any further deterioration of the concrete structure from water ingress and will therefore substantially lengthen the lifespan of the structure. The overall result is a safe, dry and usable structure (Fig. 8 and 9). ■

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