SHOTCRETING INNOVATIVE AND PRACTICAL WAYS

Written by: Wade Kathage

Moranbah North Mine (MNM) has had two significant strata related projects where existing industry strata remediation techniques were not optimal – these were life of mine strata remediation, and increasing secondary support in underground drifts.

A new solution was proposed that addressed two key criteria: reducing risk to mine workers ie removing proximity to unstable roof, reducing manual task exposures, removing people from proximity to conveyors, reducing interactions with mobile equipment, AND improved efficiency ie improved application rates, reduced curing times, meet support specifications, no impact on coal clearance availability and reduce diesel fleet requirements.

This paper discusses the result that meets these criteria by introducing pipe delivery systems and a flame proof mobile shotcreting machine with improved performance, on a conveyor mounted platform and ground level applications that provides a solution to the strata remediation issues, with possible other benefits

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The industry is yet again facing difficult times with the pressure of low coal prices and reduced tolerances to cost exposures to our operations, yet to survive in this industry it is well known over the years that such cycles do happen and will continue to happen, which means we as mine operators need to adapt and maintain control to delivery SAFE coal production and financial returns back to our shareholders and ensure our corporate family continue to have a safe and confident career with our company.

To achieve the above objectives, many successful companies have turned to innovation to assist them to find ways to get critical activities done in a safe, effective low cost method, this requires vision of key decision makers to recognize such things, they understand every aspect of their costs both in present operations and what return they would receive if the innovation work was successful. They would understand the process of risk management in all areas of business and have the ability to articulate the vision of what the innovation will produce. Innovation does not have to be seen as an additional cost, but if done right a cost reduction tool, I am happy to say that I had a manager (Glen Britton), with such a vision and ability to recognize all of the above factors and was nothing but fully supportive of the efforts of the project team, which was made up of myself, Paul Green and Dennis Bromley, plus proactive vendors heavily involved with us, with their equipment, materials and people. I true test of such innovation being successful is when asked the question are you still using it today even in hard financial times, plus stilling showing excellent safety results is yes, then you have proven that the innovation is real and effective. This then should be used as a good example for our industry, if done right, innovation must be a priority for any business, particularly in the hard times we face today, while keeping our people safe.

WHY DID WE DEVELOP THIS SYSTEM TECHNOLOGY

To create a clear picture of how this particular system was born, it is important to paint a picture of the drivers of such thinking. Moranbah North, had faced its third conveyor drift fall in August 2012, from this it was essential that a permanent low risk solution had to be found to ensure that the event would never happen again, with this in mind a full design was completed that was evaluated by multiply experts, both internal and external to the company. A project to increase the safety factor of the support in conveyor drift and the people/equipment drifts where formed. This had some key objectives that it had to achieve, that where

- Safely meet design criteria of the safety factor of 2 that could be audited and measured to be effective.
- Zero lost time injuries
- Completed the works without interruption of the safe operations of the mine
- Meet budget

All of these objectives where meet, but they came with significant challenges, for example

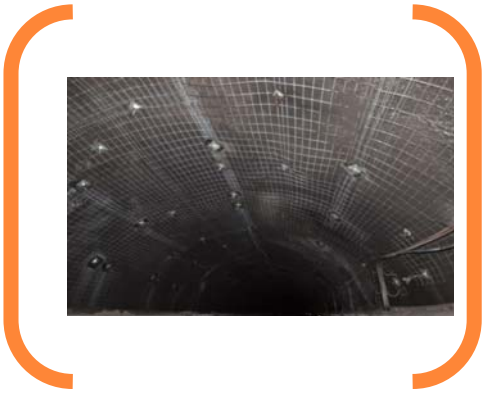
- Managing risks associated with vehicle, equipment and people interactions.
- The management of operational traffic in the P&E Drift, not stopping the conveyor belt in the conveyor drift other than operational maintenance windows.
- Proving that the quality of material, installation processes and designs where within acceptable level of risk and standards. Even the auditors where audited by additional external experts, nothing was to be left to chance.
- Maintaining the confidence of the workforce, that the solution and how we were executing the solution will be successful.

To meet these objectives and to manage the challenges we used Risk Management as our major tool to develop a plan to achieve a safe and effective outcome, but we added one more component to our thinking while going

through our risk management processes, we ensured that innovation was kept as a key possible control to our hazards to the people and project.

Some key innovation concepts where developed and managed from concept to reality, that meets the risk management requirements, some examples of these where the following:

- Logistic Management – Use of Wi-Fi telephone system in conjunction with hard barriers and exclusion zones.
- Use of conveyor mounted platform to enable safe working over the top of a moving conveyor, while men could operate on it and still move the platform while the conveyor was running.
- Pumping technology for injection of concrete behind steel sets in the conveyor drift, from the surface to underground, without stopping the conveyor.
- Although the pumping of concrete behind steel sets in the conveyor was successful, for the P&E drift, it would be too labor intensive, much higher exposure levels to persons building basically retainer walls in the P&E and the available space in the drift would had been severely comprised. We then had to relook at the shotcreting option and work out how we would be able to spray such a large amount, approximately 1400 cubic meters had to be sprayed within 4 x weeks, but we still had to meet design criteria, maintain no interruption to underground operations. Traditional methods in coal would have meant that it would have taken us 12 to 16 x weeks to complete the job, with standard materials and equipment approved for underground use in coal mines.



    - We then set out through our risk management system, to work out ways to achieve our objectives and beat the constraints.

- The lessons from what we learnt from pumping concrete in the conveyor drift were reviewed.
- We investigated all of the current practices being used for shotcreting equipment, people and type of shotcrete used, looking for safety, performance, approvals, procedures, results, quality control, competency and knowledge.
- After evaluations we conducted trials with identified vendors for shotcreting equipment, personal and supply of shotcrete that would allow us to be meet design criteria but also something that has not been done successful before due to separation issues under high pressure of the shotcrete, is it had to be capable of being pumped to the shotcreting rig. Plus the rig had to comply with all of the legislation requirements and any controls required from our operational risk assessment. The risk management processes, took into account all key legislation requirements, such as change management, introduction of new material and chemicals to site, review of relevant parts of the safety health management system on site, including new risk assessments, procedures, management plans.

- I full programme was put together in parallel to other support operations in both drifts to conduct experiments of different designs of shotcrete, including the use of a new synthetic fiber that would not block in any high pressure pumping system. Additives, grades of sand, size and shape of aggregate, use of remixing systems, where designed, set up, tested under controlled conditions to match the proposed operational conditions, then the

samples, data that was collected was sent away to offsite testing companies and also to an expert working with the a university in Sydney who is a leading expert in this field.

- The final mix, pumping system design picked, spray unit picked, procedures produced for the final test run, which was extremely successful and of course all of the data and sample where checked again as per our quality control management plan.

- Final risk assessment review and adjustment, completion of all actions, controls, procedures', management documents, sign offs for the SHMS completed and the system was installed as designed

- The results of this work allowed us to spray approximately 1,400 cubic meters of fibrecrete, with as little as 6% rebound material, approximately 200mm thick in 22 days, working only on day shift, to allow large logistical loads to enter the mine on the night shift.

- Full quality control followed and audited multiply times, cores where taken to prove effectiveness and design minimum specifications.

- Not one person was injured during this project, no damage, no equipment interaction incidents. The proof is here where rigorous risk management is used, zero harm can be achieved and be very productive and cost effective.

- After several audits, reviews, evaluations of the concrete pumping, shotcrete pumping, and conveyor mounted platforms, approved high capacity shotcreting units, cost reviews, performance of the support, it was clear that this system had the potential to solve other challenges underground, including risk reduction and safety outcomes, plus a very high potential to reduce costs.

THE OBVIOUS QUESTION WAS WHAT NEXT

A brain storming session was held with key project members and stake holders after we received final approval and certification that all of our learnings and innovations worked. A small team come up with possible targeted solutions for challenges the mine faced including, reduced

hazard exposure to persons in several process areas, strata defects, roadway maintenance/building, rib protection from heavy equipment, working around moving conveyors, possible increase speed but reduction in cost of building ventilation devices/seals, Gas mitigation, monitoring system protection, communication system protection, advancement of the logistic control Wi-Fi into the rest of the mine for communications and tracking.

THE CHALLENGES AND INNOVATION IMPROVEMENTS PURSUED

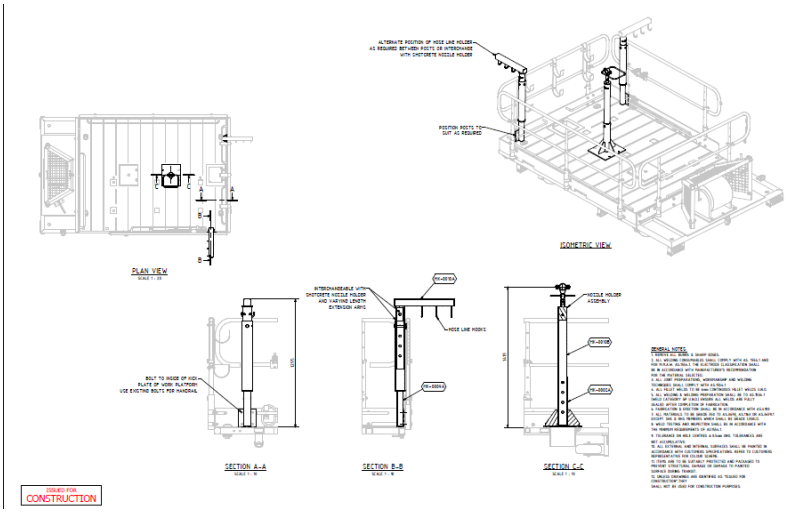
The team put forward a business plan, including full justifications for the Targeted objectives, expected outcomes including benefits of increased safety and cost reductions, methodologies, management plan, risks, issues, controls and financial justifications. We knew the price of coal and the exchange rate was continuing to head in the wrong direction, so it was seen strategically that we had to continue to innovate and expand on our innovation successes to assist the operation to safely increase production and reduce cost. As such all work selected was highly reviewed by all levels of management, but again thanks to a key value in our company and the our ability to prove results significant investment was made to carry out further advancements on our innovation learnings, including not forgetting key tools, such as the use of risk management in everything we do, when managing our projects.

The challenges to be solved:

- High capacity main haulage roadways capable of withstanding the heaviest longwall equipment during a longwall move.
- Protection of the ribs, from heavy equipment damage, thus stopping the initiation of strata defects and consistent rework that would increase the exposure of workers to secondary support of rib bolting and meshing.
- Robust water control, quality roadways to ensure comfort for operators not to be injured, while maintaining a good travel speed.
- Time was very limited and a large quantity of material would be required and applied in a very tight time frame.
- Reduction of cost of material, due to volumes involved and budget constraints.
- Reduction of risk to workers, traditional road concreting involved a high amount of manual labour hours, thus a hire exposure rate.
- Large amount of strata defects where required to be fixed to keep the main conveyor roadway open and reduce the risks to the workers and the mine. But this had to be completed, without stopping the conveyor belt. Traditionally, down time was required to

build scaffolding and workers had to managed close proximity to strata defect risks and work at height with bolting and meshing equipment.

SOLUTIONS AND METHODOLGY FOLLOWED

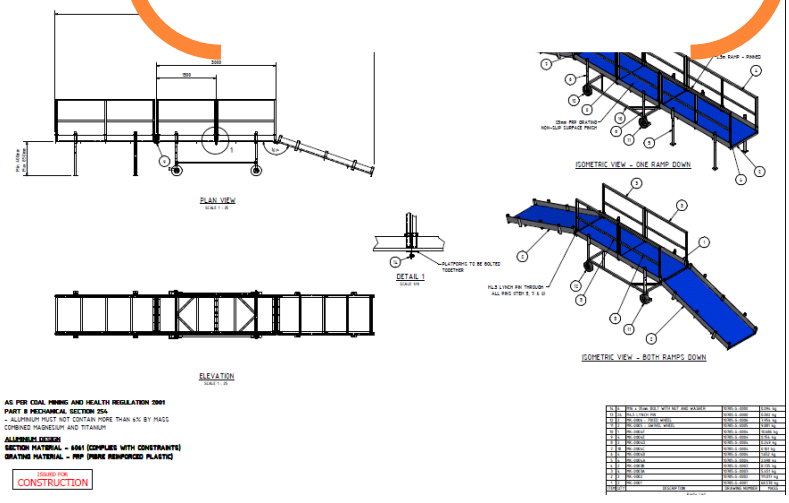


After the evaluations of the learnings from the previous innovations works, we took what worked well and left what did not behind. We still followed the same methodology of risk based management, always ensuring we remained in control of our innovation advancements, working from true data from designed trials, good engineering design, mock ups and tests. All being assessed and evaluated being put into practice via risk management, including procedures and management plans.

Key supervision and management, committed and competent suppliers, contractors, designers, scientist's continued to be essential to the success of projects efforts in overcoming the challenges via past learnings from our innovation, but also with new innovative systems being brought into play.

List of solutions

Rib Support of Strata Defect Areas



- Testing was completed on the feasibility of applying shotcrete to coal to support the rib, full geotechnical and engineering work was completed and the shotcrete mix design reviewed and adjusted to match the requirements. Approximately 75mm to 100mm of shotcrete was used to support the ribs, after the ribs where

prepared for application, such as clearing old mesh and hoses from the application area. Fibrecrete and its successful application as an alternative ground support system has three important elements:

- Quality of raw materials (e.g. sands, aggregate, cement etc) and Quality Control when combining materials to produce the wet Fibrecrete mix.
- Fit for purpose Equipment which can deliver, pump and apply the Fibrecrete at the high velocities required to ensure adhesion and infiltration into the strata
- Experienced operators who understand Equipment, Quality Control of Application and Fibrecrete characteristic

- We also found during our continual evaluation work, that it was more economical for short runs of shotcrete support to use a modified version of the traditional kibble system. Existing shotcrete being used at the mine for VCD construction has called for the shotcrete to be transported from the surface to the construction site, which could be over 10 km trip just for one kibble of shotcrete. With the Fibrecrete mix comprising of locally sourced raw materials and chemical admixtures has binding characteristics which limit segregation and allow the Fibrecrete product to be dropped from the surface via a bore hole (up to 250m). The Fibrecrete materials are then collected underground in a concrete kibble and transported to the C&C Flameproof Shotcrete Rig for pumping & placement at high velocity onto the proposed strata. We have found that there is no significant reduction in structural integrity of the applied Fibrecrete following the borehole drop and delivery via kibble. This has been evidenced by compressive strength results from cores and also round determinate panel tests which are sprayed UG following delivery from the surface.
- The reach of the shotcrete spraying unit was impressive with a reach of over 9+ m in height.

- New conveyor mounted platform was designed, mocked up, trialed and commissioned to allow personal to work above the conveyor, while it was in normal operation. The big difference between this design and the previous design used in the main drift conveyor is that this conveyor structure was not ground mounted, but actually hanging structure from the roof. The system allowed for bolting, but its main purpose was to handle shotcrete spray nozzle and hose, so the shotcreting personal could spray shotcrete into the ribs, at reasonable high pressure, whilst still maintaining good control.

- The new flameproof shotcrete rig was located at the nearest cut through to the area that was required to be supported. Extension lines where run out and connected to the mobile conveyor mounted platform or to ground mounted positions, plus a mobile ground mounted platform was also utilized, which was made of very lightweight but strong materials, to ensure ease of movement and use, with a low risk of injury to personal.

- A key aspect of this system was our ability to ensure we installed the support at a standoff position, thus keeping the workers away from potential risk areas of poor strata conditions. This type of thinking was typical in the way we approached the risk management of getting solutions to issues and threats. Again no one was injured during this project. Plus the productivity

of the work was such that the support was installed very fast, yet maintaining a very good quality control system? It was at least double the speed of the traditional method of bolting and meshing, even if they had consistent access to the conveyor being stopped.

- The economics of the shotcreting system for secondary support of rib area's is nearly $30 per square meter cheaper than bolting and meshing, but unlike the bolt and meshing the shotcrete support is a life of mine support, where is the bolting and meshing still requires maintenance over the life of the mine. In areas where access is clear for bolting and meshing such as gate roads, the economics become much closer and the cost differences are very much driven by the logistics of getting the shotcrete to the flame proof shotcreting rig. Thus further work is being carried out on ways we can improve on using closer bore holes and even using a lighter reinforced PVC piping for pumping the shotcrete longer distances without the need to install, heavy reinforced pipelines.

- The work in the conveyor road was so successful that we then progressed the rib support work into the gate roads where we have been experiencing poor confinement of the bottom half to 1/3 of the seam, which causes rib spall and eventual need to do complete re-bolting of the ribs with 6 ft. bolts and tensar mesh. We found if we put a 50 mm coating of shotcrete over the bottom half of the rib before rib spall started, which typically was around 2 x weeks after the initial mining, the confinement created by the shotcrete was such that the rib did not deteriorate at all, thus stopping the need for extensive secondary support with bolts and mesh.

Roadway Reinforcement for Heavy Longwall Move Equipment

- Like the initiatives under taken for the rib strata defects, the same methodology and principles where applied to achieve an excellent outcome of being able to spray the floor at a thinner thickness than what we would traditionally using concrete dropped from boreholes to LHDs then transported to the area for dumping and spreading by equipment roughly and to a smother surface by

hand. Instead of the 300 mm plus thickness usual used to handle the very large loads of longwall move equipment, we spray a thickness of 175 mm on the road, with a grading for water control, sometimes drains if required, with a 75mm thick, 1m high barrier on the rib to protect the ribs from heavy equipment damage.

- The shotcrete was pumped from the surface approximately 300m above ground down a bore hole to the flame proof shotcrete machine, via steel reinforced concrete pump pipelines, with associated engineering designs to manage the head pressure, blockages and emergency stop of shotcrete flow. Communications where constantly in use via the DAC, Phone and Wi-Fi Phone systems. The team managed to achieve approximately 1,500 meters of pumping shotcrete to the spraying unit and achieved over 100 cubic meters in a shift. There was how every times that we did push the limits of the mix design and the rigid nature of the piping system was not helpful for multiply turns in the underground roadway system. It was calculated that compared to the perfected use of dropping shotcrete over 320 m down a bore hole to a hydraulic driven kibble which was no more than 10 to 15 pillars away from the spray unit, it would be more economical when spraying less than 800 cubic meters in one area. But plans are on the drawing board to rectify some of these i

- The end result of this project provided the mine an extremely robust transport roadway that is still standing today, without anyone hurt during the project, no operator of the longwall move equipment where hurt due to road conditions or from damaged ribs. There was zero damage to the ribs and too date not one single crack in the shotcrete.

- Trials continued via pumping concrete directly to the ground and spread out via equipment and by hand, this also proved successful, but it was much harder on the fitness levels of the workers involved, but to their credit and as testimony to again using the risk management system, no one was injured during this trial either.

NEW CHALLENGES AROSE AND HAD TO BE SAFELY MANAGED

Due to the teams dedication to solve issues that arose and via consistent engagement with workers, management and stakeholders, systems become more mature, more stabilized and had become the way we do business in meeting some of the many challenges a mine faces every day and our obligations as people and business to ensure we do this at an acceptable level of risk, by following the proven methodologies of risk management, the systems and structures of our Safety, Health and Management Systems that each mine is required to have. But we found this not a burden, but a powerful tool to safely achieve for the benefit of all who work and depend on the success of the business and each worker being able to go home safely each night.

The challenges to be solved:

- Rib Stability problems in gate roads, the paper does talk about earlier trials that where successful and that work continued.
- High CH4 rib emissions going into the general body intake of gate road intakes, causing back ground levels to increase, causing delays and reducing the tolerances of manageable methane levels.
- Oxygen egress into goafs.
- Requirement to rehab 54 c/t shaft in B hdg and establish a travel way under such shaft to allow for a 1 direction traffic facility for going in and out of the mine, thus dramatically reducing the risks of vehicle interactions.

As we examined the above challenges, we also saw other possible opportunities that could be explored into the future as our technology evolves and becomes even more safe and cost effective.

The opportunities we recognized where:

- The encasement of our tube bundle monitoring and communication system, in way that would still allow for effective maintenance activities on the system, extensions to the system, but turn the mines monitoring system into a potential explosion proof monitoring system, that numerous organizations have aspired to have in a coal mine, as we have witnessed too many times in disasters like Pike River.

- The same concept could also be used to assist our communication devices, like our underground phones to be sheltered from potential explosions or even winds blasts, thus increasing the chances of workers to make critical contact with emergency services and management.

- There is scope via use of proven methodologies and some more sophisticated technology for monitoring real data, we could increase the ability for our tail-gates to withstand high levels of vertical and horizontal stresses, via the ability of the design of the mix to have a high flexural strength and when all sides of the roadway is confined within a suitable thick lining of shotcrete, we have the potential for the stresses be managed easier via stress distribution in conjunction with the appropriate roof support of bolts and long tendons and when required standing support to increase the direction control of the deforming stresses on the tail gate and across the beam of the tail gate side of the face, if the direction of the horizontal stress are lined up in the right direction. If successful it would also increase the chances for the tail gate to stay open longer as it deforms and effectually collapses into the goafs, but this may allow enough longer time for the ventilation restrictions to be reduced and assist with managing gas levels at the tail gate drive.

- The shotcrete has the advantage that some of our mining equipment does not have and that is too artificially create a much better supporting roadway shape for strata control, which could lead to better primary and secondary support systems.

List of solutions

- A new mix design, was trialed and implemented to ensure the shotcrete seals the methane into the coal, by ensuring we spray under high pressure into the cleat direction we get significant penetration and consolidation of the coal, combine this with silica fume, we achieve a good gas barrier, plus we produce a type of baffle system behind the shotcrete to reduce the migration of the methane to work its way around the shotcrete wall.
- Presently a Simtars Study is currently well progressed with the initial report, recording that the shotcrete mix is an effective barrier too CH4 migration and also oxygen migration.

- With the success of the gas mitigation work in the gate roads, we then used this technology to seal goaf leakage issues, with very good results, but we did find as we closed one pathway another one become more evident.

- The work required for the rehabilitation of the 54 c/t shaft and the building of a high strength and pressure under pass was very much risk management exercise with extensive engineering involved to ensure we achieved the desired results for compliance, maintain mine ventilation performance and with stand potential equipment impacts. As such not only where the risks significant they need very robust controls to ensure we have a sound acceptable level of risk for the mine.

Risk Assessments where carried out, Management Plans put in place, Change Management where followed, including any reviews of the relevant SOP's and PHMP's for the mines SHMS.

- As you will see in the photos and the associated multimedia package, the shaft bottom was rehabilitated, lined and reinforced by shotcrete.

- Steel Sets left over from the conveyor drift fall, where re-engineered and precisely put into position with mm of accuracy, and then they were sealed via use of timber and a heavily reinforced amount of shotcrete.
- Even the design of the doors where uniquely designed to ensure easy opening in a high pressure environment and the pressure chambers where designed to ensure people exiting from the return would not walk into oncoming vehicles traffic.
- Even the gas monitoring standard installation where second to none, the team working and running this job should be very proud.

IN SUMMARY

The innovation of the shotcreting system was more than just a shotcreting machine, spraying shotcrete for different purposes, there was a lot of other innovations to support the differing systems and uses we have found for this new innovative material in coal, even where it is heavily used in Hard Rock, Civil Industry and even the construction industry, significant advances where made with this work, which was to re-cap on -

- Secondary Support to Development Roadways
- Rehabilitation Works
- Ventilation Control Devices
- Gas Mitigation to strata in old workings
- UG Road Ways which interlock into the walls
- Drainage Sumps

- M&M Drift Repair
- Overcasts & Underpasses
- Conveyor Drift Rehabilitation by Hand Spraying from a movable conveyor platform
- Works completed via robotic and hand spraying using the C&C Flameproof Shotcrete Rig

We showed fibrecrete applied correctly provides a supportive membrane that forms a pressure band against the strata. This differs to civil or hard rock applications where the sprayed membrane is a support structure standing against the strata.

In UG development roadways the make-up of coal strata and the associated rock bands require a pressure forming membrane to assist in sealing the coal and holding it in place. By applying fibrecrete to the block side of a development roadway rib it distributes the load pressures over the area and prevents the coal from fretting and reduces the unravelling on the block side as load is applied. Spraying the immediate roof and the opposing walls would also further distribute load pressures.

Fibrecrete applied to required design thicknesses reduces the number of bolts required and the need for secondary support meshing of development roadways. The secondary significant benefits of fibrecrete as a ground support method are:

- Reductions in rework moving forward due to lack of mesh bagging from coal fretting as the coal has been sealed (Long term durable support)
- Significantly reduced gas concentrations in the roadways due to the inherent gas migration control which the fibrecrete layer produces once it is applied to the coal strata.

Innovative Equipment- Flameproof Shotcrete Rig & Associated Systems such as the conveyor mounted platforms, Pumping technology, Drop Hole Technology, Wireless Communications.

- C&C should be recognized for having developed with the assistance of key fellow Anglo project people/deputies such as Paul Green and Michael Bromley, the first Underground; self- propelled Flameproof Shotcrete Rig. The stand-alone diesel powered unit can be driven around the mine to pump and apply Fibrecrete as required and can be used for robotic and hand spraying operations. The rig is operated remotely and with an extendable 11.5 meter boom allows the operators to be safe under supported ground during the fibrecrete placement process.

- The Rig was developed from a significant financial and resource commitment by C&C who utilized the shotcreting knowledge of the company's Mining Project Manager (Barry Sturgeon) gained from 30 years' experience using fibrecrete as a ground support system in the hard rock industry. The machine is known as a C&C Flameproof Shotcrete Rig. The rig has the ability to spray and place 15 cubic meters of fibrecrete per hour depending on delivery cycles.

Strict Controls and Skills to achieve what we have and in the case of the shotcreting itself the following:

Quality Control of Raw Materials & Fibrecrete wet mix

The Fibrecrete mixes are produced by Hanson Construction Materials to strict Quality Control Standards from a computerised onsite batch plant at Moranbah North Mine.

All raw materials (sands & aggregates) are provided by Hanson and processed to produce the correct shape and graded to provide a uniformly consistent grading which when combined with cementitious materials, poly fibres and chemical admixtures produces a fit for purpose Fibrecrete wet mix with significant resistance to segregation.

QC of raw materials is monitored through the following tests:

- Aggregate wet & dry strength variation
- Aggregate CBR
- Sand & aggregate grading curves
- Stockpile moisture contents

The combination of raw materials, water, cementitious materials and chemical admixtures is controlled by experienced Hanson operators and a state of the art computerised batch plant. Loads are slump tested prior to delivery to ensure compliance with water cement ratio parameters. Super plasticiser is used to alter workability of the fibrecrete which does not affect the WC ratiolowing points where critical.

Testing of Fibrecrete Mixes

The structural integrity of fibrecrete mixes is tested by undertaking:

- Compressive strength tests (7day and 28 day) to AS3600
- Round Determinate Panel Tests

If sections of roof are sprayed then Meyco penetrometers are used to check for safe re-entry

Thickness Control on Application

Application thickness is controlled by utilising experienced operators and installing depth control indicators which are left in the Fibrecrete as it cures.

The depth indicators provide a quick visual check which demonstrates compliance with the Fibrecrete ground support plan for the area.

Key benefits associated with Fibrecrete as a ground support system

- High velocity impact upon application of fibrecrete allows infiltration into the coal strata and produces a supportive sealing layer which prevents coal fretting
- Significantly reduces the amount of meshing and bolting required for secondary support
- Cheaper than mesh and bolt installation
- Minimal if any rework once applied for life of mine
- Gas Migration Control in UG roadways which improves development production and provides a safer work environment
- Cheaper, more durable ventilation control devices which gain ratings quicker and can be locked into surrounding strata
- Thinner roadway pavements when compared to traditional normal concrete and mesh
- Simply delivery method with no segregation of fibrecrete mix
- Significant reduction in manual handling when compared to mesh and bolt as fibrecrete is applied by robotic spraying

The workers involved where well trained and motivated people, who worked well as part of an overall team, from Anglo American, C&C and suppliers like Hanson's, all pulled together to ensure the success of the various projects and the continued success of advancing this innovation.

IN CONCLUSION

There is still more work to be done to advance this technology further at the mine and throughout the company, we would encourage other mining companies to come and learn what we have so they too can benefit from the safety and mine performance, even during these difficult times.

I would also like to say thank you to the Inspectorate who have been active supporters of the work being done at Anglo American Moranbah North Mine. But I would like to give a particular special thanks to 2 very hard working deputies and check inspectors who have put their heart and soul into making these innovations work and be so effective, as in Paul Green and Michael Bromley, to whom have also been well supported by quality contractors, work mates and have had the unwavering support of the original senior sponsor who continues to support these innovative activities Mr. Glen Britton – Manager of Underground Operations Australia for Anglo American.

One last point, due to the learning from this work, a new innovation is underway, that will greatly enhance the safety and productivity of the mines, and I look forward in sharing this innovation with you in the future.

A special thanks for the people who worked so hard in helping me put this paper and the multimedia package together

FURTHER MEDIA AVAILABLE IN PRESENTATION PACKAGE