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NEW TECHNIQUE TO MANAGE THE RISK OF ROCK FALLS

Consequences of rockfall events observed around abandoned portal entries at the base of the highwall at the Beltana mine (Glencore). Red arrows indicate larger blocks identified nearby the portals.

Rock falls are a significant safety hazard in the highwall mining environment; they can cause serious injury to personnel and damage to infrastructure and machinery. A new technique developed by University of Newcastle researchers to accurately investigate the efficiency of rock fall drapery systems and to quantify the residual hazard is helping mine personnel to manage this risk.

The new technique applies 3D digital photogrammetry, discrete fracture network modelling and kinematic analysis to generate an accurate representation of the potential unstable blocks (size, distribution and shape). This information is then combined with a new 3D discrete element rock fall model in order to obtain an accurate prediction of trajectories and velocities for blocks which are representative of a highwall. The efficiency of the rock fall protection measures can then be investigated and the design of portal entries optimised through a more comprehensive rock fall hazard assessment.

In general, the risk of rock falls is managed using active or passive protective measures. Active protection systems are designed to prevent instability from occurring. They are usually installed on the slope/highwall itself, acting directly on the rock surface and preventing the blocks from detaching from their original position. The main active protection systems include anchors, rock bolts and grouted bars. However, rock scaling, berms and excavations, blasting machine and modification of rock mass hydraulic conditions are also considered to be active protection methods.

Passive protection systems are those that control the block's motion and intercept and stop rocks falling from the slope/highwall. Passive protection systems include flexible rock fall barriers, such as catch fences, attenuators, catch ditches, reinforced (or unreinforced) embankments and simple mesh drapery systems.

Drapery systems commonly used at Australian mines are placed against the rock surface and, combined with face bolting, fall within these two categories. They directly act on the stability of the blocks and also control their fall should failure occur. Drapery systems aim to dissipate the energy from the falls and limit the distance blocks land from the highwall.

The integrated approach developed was the result of the combination of a series of tests carried out at Beltana mine in New South Wales and 3DEM numerical analysis. During the tests rock fall motions restrained by a drapery system were compared with those where a drapery was not used. Three dimensional (3D) block trajectories were recorded using a pair of synchronised, stereo, high speed cameras. Site specific information on block velocities and impact energies on the portals were derived from those recordings.

The experiments found that the drapery's mesh forced the blocks to have more impact with the wall, which is a source of energy dissipation, thereby resulting in lower final impact energies on the portals compared with cases where a drapery system was not used.

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Researchers were able to quantify the energy dissipation along the drapery. Almost one-third of energy dissipation was attributed to the interaction of the block with the drapery. Overall, rock falls restrained by a drapery resulted in impact velocities on top of the portals of less than 50 per cent of those without a drapery. The drapery also restrained impacts close to the highwall with an impact zone on top of the portal reduced by more than 60 per cent.

Project Leader Anna Giacomini said by using images of the highwall, researchers could identify the geometries and volumes of potentially unstable blocks without the need to stand close the highwall.

“While each mine site is different and each highwall has different needs depending on the geological configuration of the outcropped rocks and how the highwall has been excavated, our numerical tool can be used at any mine. We can provide mines with the information they need to manage the risk of rock fall at their particular site,” she said.

“Just imagine we have new mine site where we want to install new draperies. Using this technique we can identify the specific shape and size of blocks that could detach and calculate the specific impacts a drapery will have, such as a reduction of the distance the block will fall from the highwall and the energy in kilojoules that the drapery will help to dissipate.

“That’s very important because it will give an indication of the residual hazard associated with rock fall drapery system protection measures and it will provide crucial information for the safe and effective design of portals and roads in open cut mines.”

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