Safety In Mines Research Advisory Committee
Project Summary: GAP 852

Project Title:	Experimental validation of a mine-wide continuous closure monitoring system as a decision making tool for gold mines		
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Category:	Gold and Platinum	Instrumentation for hazard identification and support design	Rock Engineering

Summary

Previous fundamental research projects have indicated the value of continuous closure measurements for improved support design and hazard assessment and for quantifying the effect of seismicity on stope closure. This project examined the feasibility of a mine-wide continuous closure monitoring system. A RMT remote reading telltale system was modified to operate as a closure system and installed at Mponeng Mine. Unfortunately, this system did not succeed in collecting data from a large number of closure stations. Nevertheless, some valuable lessons were learnt. The two most serious problems experienced were communication problems from underground to surface and maintaining continuity of the cabling in the stope.

Three types of closure meters were designed and evaluated during the project. These designs operated satisfactorily. The cable network used in the stope presented a major challenge in terms of maintenance. Mining activity and falls of ground resulted in frequent cable damage. In conclusion, cable connections in the stope for a mine-wide closure system is not seen as a viable option. Radio communication is probably the best method to link closure meters to a data logger located elsewhere in the stope. Further problems were experienced with the communication system to surface. The RMT system required a copper link to surface. This was not available at Mponeng and attempts to use the fibre optic network were not successful. In future, mine-wide closure systems should be designed with the necessary flexibility to link-in with the existing mine communications systems, whether it is fibre optic, copper or leaky feeder.

Following the problems experienced with the RMT system, SIMRAC requested Miningtek to use the remaining funds to collect data from one site only using standalone closure meters. The site chosen was the 109/51 area at Mponeng Mine. Four panels were instrumented with CSIR closure meters. During the three month period of monitoring, only two significant events occurred. These were seismic events on 21 November 2002 and 17 January 2003 causing significant falls of ground in some of the panels. A very significant finding for mine-wide closure monitoring was that there is a very good correlation between the amount of seismic closure in the panels and where the damage occurs. In both cases the falls of ground occurred in the panels with the highest amount of seismic closure, even though the seismic events located closer to other panels that remained undamaged.

A useful parameter calculated from the closure data is the closure ratio (CR), which is the ratio of the instantaneous blasting closure to total closure following a blast. Note that this parameter is only defined for the closure following a blast and not a seismic event. Calculation of this closure ratio for closure data collected in earlier projects showed that it is a very good measure to identify different ground conditions and possible hazards. Closure ratio values of greater than 0.4 are typically associated with strain bursting conditions, while low values (typically < 0.1) are associated with significant risks of falls of ground. The average closure ratio calculated for the experimental site at Mponeng Mine is 0.5 (Figure 1). No face bursting occurred during the period of monitoring so any possible changes in closure ratio preceding these bursts could not be investigated.

Some numerical modelling using DIGS was conducted to verify the usefulness of the CR parameter. It was found that these initial results support the utility of the closure ratio in discriminating the response of different geotechnical environments. However, the present numerical simulations do not support more definite trends of the closure ratio as a function of time or as a predictor of incipient face stability.
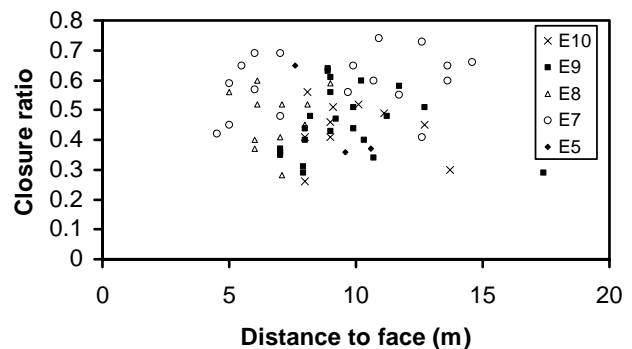
Figure 1. Closure ratio as a function of distance to face for the panels at Mponeng Mine in the 109/51 area.

Conclusions

An important step to improve the hazard assessment capabilities of rock mechanics engineers would be to increase the real-time data that is available to indicate the rock mass behaviour in every stope panel. The development of a mine-wide closure system would be of great value as this would assist in the design and assessment of support on a continuous basis, identification of geotechnical areas and hazardous conditions.

This study showed that the implementation of a real-time mine-wide closure system, unfortunately, would represent a major challenge. Cabling to connect the closure meters in the stope environment is not seen as a viable option. Radio communication is probably the best method to link closure meters to a data logger located elsewhere in the stope. While the necessary technology is being developed, standalone continuous closure meters do, however, provide substantial additional information on rock mass behaviour and their use throughout the mining industry should be widely encouraged. As part of this project, a guide for the use of continuous closure data was developed.

The additional continuous closure data collected during this project provided valuable new insights. During damaging seismic events, it was found that the greatest damage occurred in panels where the largest seismic closure was recorded and not necessarily how close the panel was located to the seismic event. Although expected intuitively, this closure data was some of the first data supporting the hypothesis that during damaging seismic events, areas with the largest seismic closures experience the most damage. If mine-wide closure systems can become a reality, this would greatly assist mine personnel to identify locations where significant damage could have occurred after large seismic events.

Calculation of the closure ratio (CR) showed that it is a very good measure to identify different ground conditions and possible hazards. This work was supported by numerical modeling results, which showed that the closure ratio is very useful in discriminating the response of different geotechnical environments.