

https://dspace.org/

Concept development of a smart rock engineering system for real-time decision-making and risk minimization in deep level hard rock mines: a digital mining approach

Kwiri, Joseph

2018

https://hdl.handle.net/10539/26622

Kwiri, Joseph (2018) Concept development of a smart rock engineering systems for real time decision-making and risk minimization in deep level hard rock mines,University of the Witwatersrand, Johannesburg, <http://hdl.handle.net/10539/26622>

Downloaded from a DSpace repository. https://dspace.org/

ABSTRACT

Huge milestones have been achieved in an attempt to reduce rock related accidents in the South African mining industry. However, ZERO HARM has not yet been accomplished. Despite the mining industry being active for years, accident statistics are still high compared to the mining industry in Australia and United States of America, in particular gold mining. Gold deposits occur in deep and ultra-deep levels where the stress levels and rock related risks are high making mining, more difficult and riskier. This is further exacerbated by the intensive labour force at such mining depths. Risk management strategies have been formulated and refined over the years and their success is not questionable as there have been, significant reduction of fatalities over the years. However, the number of fatalities over the years is still too high. As an example, fatal accidents exceed twenty from January 2018 to July 2018. These unfortunate statistics indicate that existing strategies to reduce rock engineering risks, have limitations. Surface mining, civil and petroleum engineering have more advanced risk management technologies compared to underground mining. The attributes of these technologies can be used to develop better underground risk management strategies. Such attributes include remote operation, integrated sensor system, and the ability to predict impending danger. Some of these attributes can be compared to human body and brain as it is an ideal system that smart systems should mimic in particular decision making and actioning of decisions made as well as the ability of skin to sense, repair itself and insulate. Used with advanced material science, such properties of the skin (sense, repair itself and insulate) can be used to make a type of support that can reduce support replacement costs and ventilation related operating costs. The conceptual smart rock engineering system developed consist of sensors, expert system for data analysis and decision making, wireless communication system and an emergency and preparedness response plan through automated alerts which are received by the miner in the stope area. The system should measure a number of parameters including stress, water level, convergence, face advance, face profile, loading of support and ground movement. The results are displayed concurrently on a video wall in the control room area. A case study was done to compare what is currently available in the Digital Mine Laboratory and the conceptual smart rock engineering.

From this case study, opportunities to improve the system installed in the Digital Mine Laboratory were identified. The Botswanan earthquake, which occurred on the 3rd of April 2017 at 17:40 Coordinated Universal Time (UTC) was a critical event to test the functionality of the system installed in the Digital Mine Laboratory. Recordings from the Digital Mine Laboratory were compared with other ground sensing technologies (United States Geological Survey (USGS) and GEOFOrschungsNetz Global Seismic Network (GEOFON) systems). which also captured the Botswana earthquake event USGS and GEOFON systems recordings suggested that there are a number of possible mechanisms that could have resulted in the earthquake. Compared to the USGS and GEOFON systems, Digital Mine Laboratory system could not provide a self-analysis data that could be used to determine the source and source mechanisms. The Digital Mine Laboratory system's success in recording the Botswana earthquake event is an indication that the system can be developed and or improved. For a comprehensive analysis, more data from various sensors needs to be collected, for example, by connecting to the national seismic monitoring system or to the local mines seismic monitoring system. Such connections will enable the development of a better self-analysis system and possibly prediction of future events within the Digital Mine Laboratory.