Technology News

From the Bureau of Mines, United States Department of the Interior

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Reduction in Rockfall and Blast-Produced Overbreak in Underground Mines

Objective

Use controlled blasting techniques to reduce blast-produced overbreak damage to underground mine ribs and back for both safer working conditions and improvements in productivity.

The Problem

Blasting is used in metal and non-metal underground mine stopes, drifts and crosscuts to fracture rock to be excavated and further processed. Standard blasting also produces fractures in the rock beyond the desired excavation area. This is sometimes evident by rough surfaces, undercutting and other signs of excessive damage. This damage contributes to rockfalls in the mines, a major cause of injuries and fatalities and equipment damage.

A variety of controlled blasting techniques has been developed for civil engineering projects where long-term stability is essential. For several reasons, these methods are not widely used in mining. For example, these methods incur additional costs and time; there is little need to maintain stable openings over long periods of time; and there is the perception that corrective remedial techniques, such as rock bolting, are more practical. Basically the benefits of these methods are not demonstrably clear for application in underground mines.

Approach

Bureau of Mines researchers evaluated controlled blasting techniques at two underground mines: the White Pine room-and-pillar copper mine in upper Michigan, and the stoping operation of the Homestake gold mine in Lead, SD. Designs were intended to reduce overbreak while still producing adequate fragmentation and throw. In addition, practical factors were emphasized, since researchers realized that if overly complex approaches were used, the methods would probably not be adopted. At both mines, the general approach was to reduce and control blast energy in perimeter holes.

Test Results

At White Pine, the major hazard is the spalling of sandstone from high on the ribs. Two approaches were tested: decoupling by string-loading undersized, low-energy cartridges, and the use of millisecond (ms) delays to reduce initiation time scatter. Of the four permutations of short and long delays and coupled versus

decoupled, the best results were obtained with ms (short) delays and decoupling.

At Homestake, mining is performed using vertical crater retreat (VCR) and the concern is about rockfall from hanging walls in the production stopes. The Bureau-developed technique involved decoupling using cardboard tubes in the 6-1/2 inch blast holes against the hanging wall. These 4-inch ID tubes were loaded with 27 lbs of ANFO instead of the standard 60 lbs of emulsion or watergel normally used.

Because immediate improvement was noted at Homestake, the mine continued to experiment after the Bureau's efforts ended. The mine has tried or is proposing to try smaller tubes, low-energy explosives, air gaps, presplitting, timing control and combinations of these. Such methods not only provided safer and more stable stopes, but clearly decreased ore dilution.

In addition to experimental blast designs, Bureau of Mines' researchers applied a variety of techniques to measure and evaluate overbreak, including seismic refraction, photographic profiling, water integrity and long-term indices, such as ore dilution. Generally, photography and ore dilution worked the best. The seismic methods were not as useful as they had been in surface studies using tomographic mapping.

For More Information

Bureau of Mines researchers have written two papers and published them through the Society of Explosives Engineers. The papers describe the White Pine project in 1989 and the Homestake research in 1991. Both are published in Society conference proceedings. They are also available from research personnel at the Bureau's Twin Cities Research Center, 5629 Minnehaha Avenue South, Minneapolis, MN 55417. David E. Siskind (612) 725-4598 or Larry R. Fletcher (612) 725-4533 can answer questions about this work and supply copies of papers.

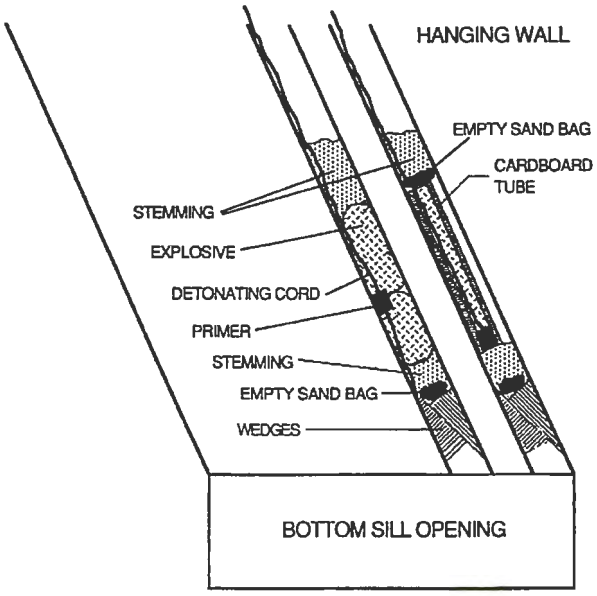

Figure 1.—Decoupled blastholes along hanging wall in Homestake mine VCR stope.

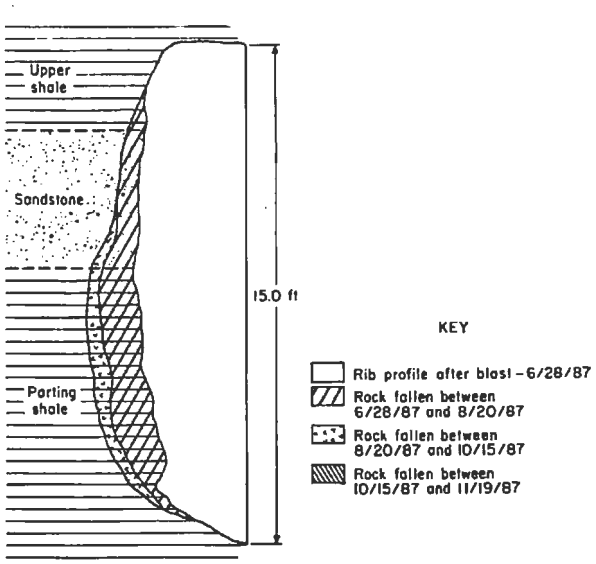

Figure 2.—Composite line drawing showing rockfall from left rib of decoupled rib holes and fast delays at White Pine room and pillar mine.