Technology News

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Reprint with correct graphics

Analysis of Longwall Pillar Stability (ALPS) Method for Sizing Longwall Pillars

Objective

Improve ground control in longwall gate entries by developing a practical method for evaluating longwall pillar designs.

Background

Longwalls have emerged as the most important technology to be applied to underground mining since the continuous mining machine. Longwall mines currently produce more than 30 pct of all the underground coal mined in the United States, up from less than 5 pct just 15 years ago.

Safe longwall mining depends on maintaining ground control in the gate entries, the lifelines that provide access to the longwall face. In multientry retreat mining as practiced in the United States, rows of chain pillars are left to protect the gate entries (see figure 1). Chain pillars are subject to severe and complex abutment loads during the process of longwall panel extraction. The design of these pillars is often the single most important element in gate entry ground control and has been the subject of intensive Bureau of Mines research.

Approach

Bureau of Mines efforts have resulted in the development of a method for evaluating longwall pillar designs called the Analysis of Longwall Pillar Stability (ALPS). ALPS was initially based on underground measurements made at 16 longwall panels in 5 mines and 4 states. At each of these panels, instruments were installed in the pillars to monitor the stress increases that occurred as the longwall face was extracted. The measurements were used to develop empirical equations for predicting longwall abutment loads. The measurements were also used to test the validity of available pillar strength formulas for longwall applications.

After it was developed, ALPS was tested by back-analysis of 84 longwall mining case histories. Both "successful" and "unsuccessful" longwall pillar designs were included among the case histories, which were obtained from all the major longwall mining districts. It was found that the ALPS stability factor (SF) was less than 1.0 for 88 pct of the unsuccessful designs, while the SF for the successful designs usually exceeded 1.0 (figure 2).

How It Works

The purpose of ALPS is to help size longwall pillars to carry the abutment loads to which they will be subjected. It consists of three basic elements:

- Estimation of the load applied to the pillar system.
- Estimation of the strength of the pillar system.
- Determination of the Stability Factor and its comparison with a design criterion.

Three different loading conditions, representative of headgate, bleeder, or tailgate pillars, may be employed

in the analysis. ALPS may also be applied to pillar designs employing any number of entries and any combination of pillar widths.

ALPS is well-suited for preliminary design, where SF's of 1.0-1.3 are recommended. ALPS does not directly consider such factors as roof and floor geology, however, so it is most effective when it has been "calibrated" with local experience. The method is not applicable to the pure yield pillar designs used on some western U.S. longwalls.

A computer program has been prepared to aid mine planners in using ALPS. The program is written in the BASIC computer language for an IBM PC or compatible. It is extremely user-friendly and may be easily accessed by those with little or no computer background. The program features interactive data input and an opportunity to check and change the data both before and after the calculations are performed.

Applications

The ALPS method has found wide acceptance within the mining industry, particularly in its new computer format. Nearly 150 copies of the ALPS computer program have been distributed, with users found at more than 85% of U.S. coal companies that employ the longwall technique. ALPS has already been used to help size pillars for new longwalls in Illinois, West Virginia, and Colorado. Mining consultants and regulatory agencies have also made extensive use of ALPS. Many leading mining schools, including Pennsylvania State University, Southern Illinois University, the University of Kentucky, and West Virginia University teach the ALPS method in undergraduate, graduate, and extension courses.

Current Bureau research is directed toward expanding ALPS to consider all aspects of gate entry design. Studies have been conducted at 45 longwalls to evaluate the interaction between pillar design, roof geology, and artificial support in longwall gate entries. The ultimate goal is to help mine planners select the right combination of pillar sizes and roof supports for their site-specific geologic conditions.

For More Information

A full description of the ALPS method, including its development and use, is given in the Bureau's Information Circular (IC) 9247, "Pillar Design Methods for Longwall Mining." For a free single copy of this IC, write to the Bureau of Mines' Publications Distribution Section, P.O. Box 18070, Cochrans Mill Rd., Pittsburgh, PA 15236-0070.

Additional information and single copies of the ALPS computer program may be obtained by contacting the principal investigator:

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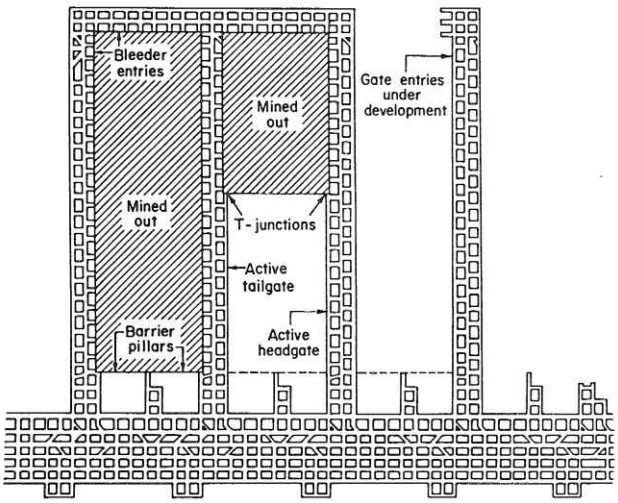

Figure 1.—Typical longwall panel layout, showing chain pillars in development, headgate, tailgate, and bleeder entries.

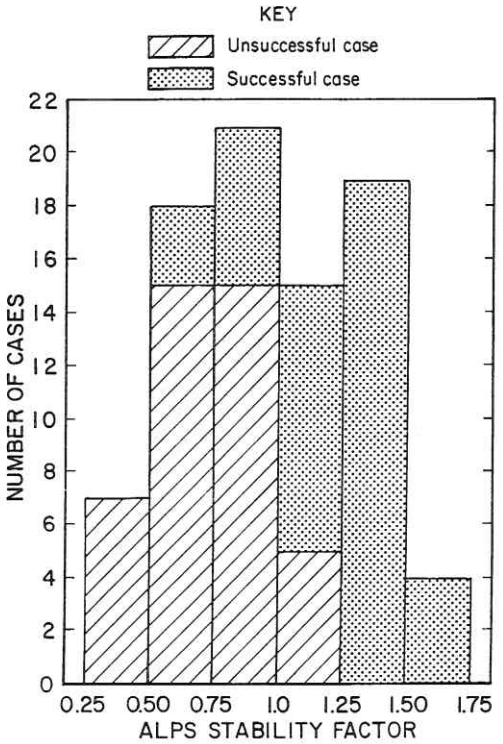

Figure 2.—ALPS stability factors calculated for 84 longwall pillar design case histories.