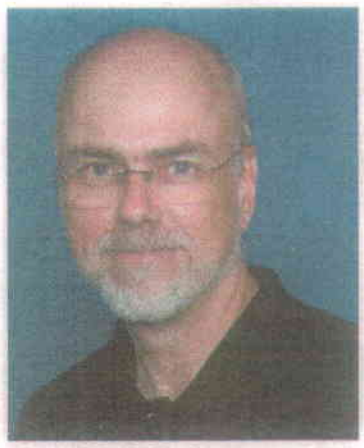
Intelligent Roof Bolting Drilling Operations

R Anderson, J.H. Fletcher & Company, with co-author L. Prosser, NIOSH-PRE gave a presentation to the Ground Control Conference **Improving the Capability for Real Time Assessment of Roof Conditions Through Intelligent Roof Bolt Drilling Operations.**

Advance knowledge of roof conditions can lead to improvement in roof control strategies that will reduce roof falls and ultimately will reduce injuries to mine workers. J.H. Fletcher & Company, in cooperation with West Virginia University, has been developing a system to meet these needs by collecting torque, thrust, and rotation speed data during drilling operations.

This all began in 1992 when a PLC was added to roof bolters. Drill control units were then added. In 1999 two foam voids were detected in concrete and the data was recorded and analyzed. Additional software was developed and recent improvements in analysis algorithms to detect anomalies in the roof structure as well as various display enhancements for real time mapping and evaluation of roof structures have been incorporated into current Fletcher information display systems **(see Figure 1)**.

The advantages of real time mapping are many. There is now an abundance of data which is gathered and analyzed. Every hole that is drilled in automatic mode has a graph displayed and corresponding data file recorded for analysis. Trends are visible as drill hole information from several holes are displayed side-by-side in real time during drilling or can be recalled from saved files for a historical perspective. No additional work or equipment is required and consistent results are possible. Historical records are created with data files backed up on a flash drive and carried above ground for later viewing and analysis by mine engineers or geologists. Trending shows what other methods may miss and the computer and display have other uses such as part books, operations manuals and maintenance manuals, and image files. Video from a back-up camera or bore scope can be viewed. Data collected by the computer can be used for machine diagnostics and event logging.



Bob Anderson

Several improvements have been made to the original system. These include a video display, print function, explosion-proof enclosure for use in coal, and software revision for a new drill control unit (DCU) and pendant recorder.

In another joint project with WVU, a test machine was built for use in an underground coal mine. An older single boom roof bolter was rebuilt with modern components, including the latest generation of drill head and drill control unit. The Fletcher information display was installed in an explosion-proof housing on the machine. **Figures 2 and 3** show the coal test machine and the information display.

The machine was first tested in the laboratory and then moved to a West Virginia coal mine. Testing in the mine is shown in **Figure 4**. The first location where the system was tested was close to the mine opening and showed very little change in the roof structure throughout the drilling depth. Approximately 60 holes were drilled at different feed pressure and RPM combinations. Two core drill samples were taken from this area for analysis at WVU. The drill data files on core drill samples were unremarkable showing a continuous homogenous material in the mine roof.

The test machine was moved to another section of the mine where there had previously been roof problems including a large roof fall. **Figure 5** shows this area and gives a cross-section of the roof strata. In this area 30 boreholes were drilled and two more core samples were taken. The core samples had several discontinuities and the drill data files showed events as well. When viewing the whole graph side by side, it was obvious that there was some change in roof strata at a depth of about 15" **(see Figure 6)**.

Scoping holes were also analyzed using a small borehole scope less than 1" diameter. Video files were recorded for each hole. Discontinuities were found in almost every case at or near the location indicated by the drill data files. Fifteen more holes were drilled in this area with similar results. Even when no open voids were detected, the whole graph showed trends such as the locations of soft bands relative to the bolting horizon. The system was also tested underground in limestone mines with NIOSH accompanying J.H. Fletcher in observing these tests and reviewing these encouraging results.

It was concluded that no one method shows everything and the system needs to be adjusted for individual machines and mine conditions. Looking at trends gives a more accurate picture than individual data samples. The Fletcher Information Display is an ongoing research and development project that is still evolving.

Fig 1 Fletcher Information Display

Fig 2 Rebuilt Roof Bolter

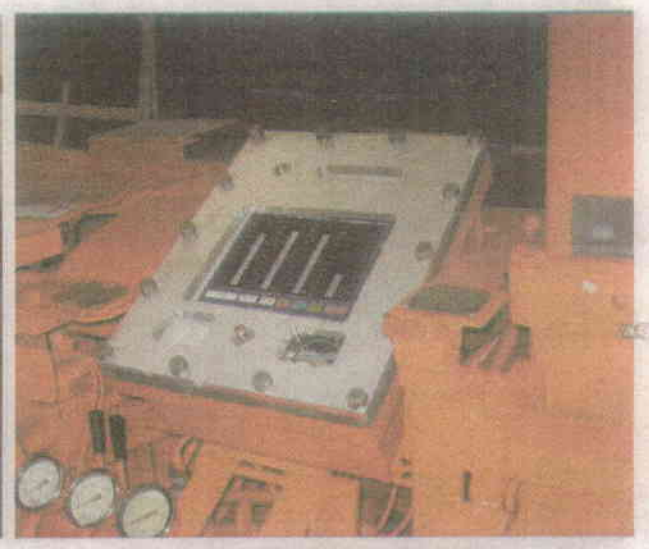


Fig 3 Explosion-proof Housing

Fig 4 Testing in the Mine

Fig 5 Roof Fall Area

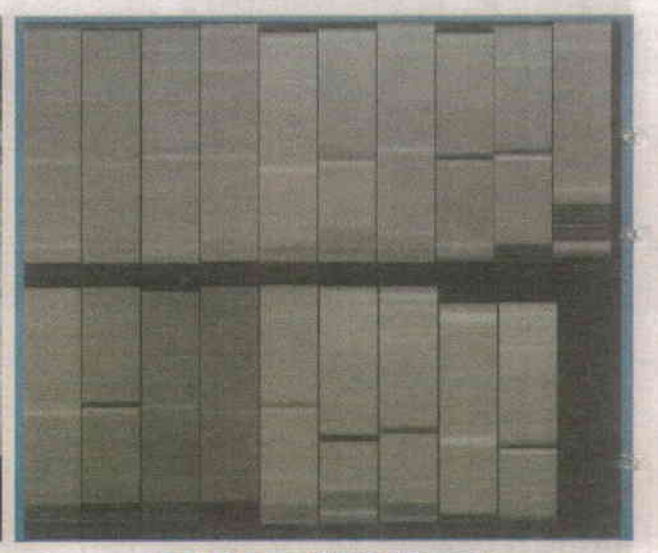


Fig 6 Discontinuity Trends