Topical Collection on Mine Ventilation

Experimental study of improving a mine ventilation network model using continuously monitored airflow

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Special Extended Abstract

Mine ventilation simulation software has become an essential tool for the mining industry to design and manage mine ventilation operations. Building a well-calibrated mine ventilation network is time consuming, however, and requires great effort. In the last several decades, the mining industry has seen a steady increase in the use of air velocity sensors to monitor airflow and detect unexpected abnormal airflow in some key locations in underground mines. The present research work was carried out to explore the possibility and methodology of calibrating a ventilation network model using atmospheric monitoring system (AMS) data on a routine and ongoing basis.

Data collection

In order to study how to use continuously monitored AMS data to calibrate and tune a ventilation network, a mine-wide AMS with eight measuring stations was installed in the Safety Research Coal Mine (SRCM) to measure air velocity, temperature and other atmospheric conditions. The airflow velocity and other parameters were continuously recorded every 10 minutes for a month without any unnecessary interruption from mine activities. To obtain the sensor location correction factor for each AMS velocity sensor at the SRCM, the average velocity at each sensor plane was measured using the moving traverse method with a hand-held anemometer once per day for eight days. At the same time, the velocity sensor reading at the time of the traverse measuring was recorded as well.

Results and discussions

It was observed that the fluctuation of the air velocity readings from airflow sensors was largely attributed to the air temperature variation. Figure 1 provides an example of how well the temperature and air velocity are correlated at one of the AMS stations (S1). Due to the fluctuation in the air velocity readings, it is important to use the time-averaged air velocity value for the ventilation network calibration to avoid the error of using instantaneous reading from all velocity sensors.

To obtain the average velocity for the calculation of airflow rate in an entry, the corresponding point sensor reading needs to be converted to the average air velocity using the sensor location correction factor. The correction factor at each sensor location was calculated using the measured

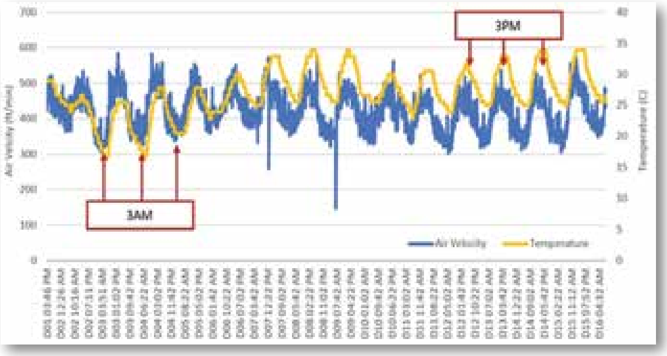

Fig. 1 Monitored air velocity and temperature at AMS station S1.

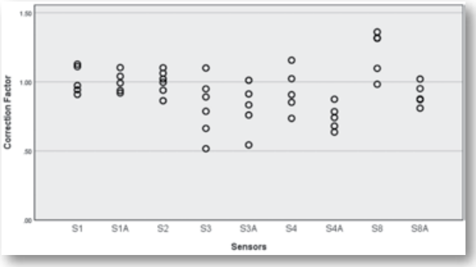

Fig. 2 Correction factors for selected sensor locations.

average air velocities with a hand-held anemometer and monitored air velocities in a time span of eight days, and the variation of the correction factors for different sensor locations is shown in Fig. 2. The correction factors for each sensor fall into a relatively large range; therefore, it is necessary to obtain the average correction factor at each sensor location. The average correction factor at each sensor location is applied to convert the sensor velocity reading to the average air velocity in this paper.

The purpose of ventilation network calibration is to adjust the airway resistances to allow the simulated airflow to match the measured airflow. Before a mine ventilation network can be calibrated or updated, the airways where the resistance changes occur need to be determined. Then the 24-hour average air velocity of AMS velocity sensor readings for that airway was obtained and modified using the appropriate correction factor to get a more accurate airflow rate for the calibration. One of the advantages of using AMS sensor data to obtain airflow rates over the manual spot check is that the AMS method can produce a time-averaged airflow rate, while the spot check only produces the airflow at the moment of measurement.

Conclusions

A new method was developed to calibrate a mine ventilation network model using the continuously monitored AMS air velocity. The method was demonstrated using the mine ventilation network model of the SRCM and monitored AMS data. Results from the study indicate that the instantaneous air velocity data cannot be used directly for the ventilation network calibration because of fluctuations. It is found that temperature and air velocity readings are well correlated. The sensor location correction factors were obtained to be used to convert the measured point readings to the average velocity over the cross section of the airway. Results from this study demonstrate that the continuously monitored AMS air velocity data can help mine ventilation engineers better calibrate their ventilation network models to achieve more accurate ventilation simulation results. ■

Disclaimer

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References

A list of all references is available in the full paper.

Stress redistribution in a longwall yield pillar – A comparison between active seismic tomography and theory

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Special Extended Abstract

Safe, efficient underground mining is dependent upon proper pillar sizing. Pillar sizing is typically based on a combination of observation of prior behavior, point measurements, theory and numerical modeling. The actual stress redistribution within a pillar, while assumed for many years, has rarely been imaged. Such imaging can help confirm whether or not theoretical and numerical modeling methods agree with actual conditions within a pillar.

This research presents a case study from a longwall mine in the western United States. A two-entry, gate-road yield pillar in the headgate of the mine was instrumented with seismometers and convergence monitoring stations, and was monitored over a period of about six months as the longwall face approached the pillar. In this paper, the stress distribution imaged using seismic tomography is compared to the stress distribution expected from theoretical models, geotechnical measurements and numerical models. The tomography results generally agree with those proposed by theory, convergence measurements and numerical modeling results. The agreement of the methods provides validation for the theorized stress redistribution, and this study provides further evidence that tomography can indicate the redistribution of induced stress within a mined rockmass and is another tool available to ensure that mining is conducted safely and efficiently.

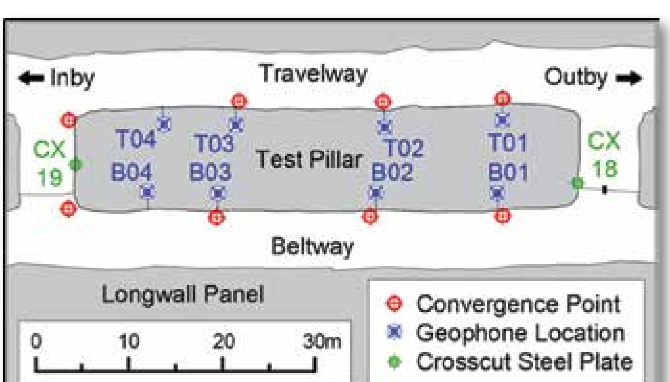

Fig. 1 Locations of geophones and convergence stations.

Background

Review of coal pillar design indicated potential shapes for the stress distribution within pillars by showing that the stress distribution assumed in the Mark-Bieniawski pillar design formula is a pyramid for square pillars and a rectangular, elongated pyramid (with a linear apex) for rectangular pillars [1]. The load is a maximum in the center of a pillar (at a point for a square pillar and along a line for a rectangular pillar) and a minimum at pillar ribs. The ultimate strength