



Technology News

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



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Impact Assessment and Blast Design for Surface Mines With Low-Frequency Vibration Problems

Objective

Identify abnormal low-frequency blast vibrations. Develop blast design procedures for such adverse vibration cases, including the selection of delay times based on ground conditions, vibration frequency, and structural response.

The Problem

Research by the Bureau of Mines and others has demonstrated how structural response and the potential for cracking and other damage depends on blast vibration frequency in addition to particle velocity amplitude. The Bureau has published recommended criteria for blasting near low-rise residential-type structures; criteria that specified frequency-dependent amplitudes.

The typical vibration frequency from surface mine and quarry blasting is 20 hertz (Hz). Sites have been found, however, that regularly produce ground-roll-type waves with frequencies as low as 4 Hz. The most serious cases are those where vibration frequencies fall in the natural frequency range for structures of 4 to 12 Hz. Such vibrations have a higher potential for causing damage to residential structures, particularly at the low end of this frequency range, because of the resulting high strains these frequencies produce in structural materials.

Vibration frequencies are influenced by such variables as geology, distance, and blast design (mainly delay intervals), and blast design is a controllable variable. At a minimum, operators must be able to identify a low-frequency problem, know what measures can be used to minimize the impacts, and what tools are required to provide increased design control of blast vibrations.

The Approach

The Bureau studied low-frequency blasting vibrations from surface coal mines in Indiana with support of the Office of Surface Mining, Reclamation and Enforcement. The first mine investigated had extensive near-surface abandoned workings and a history of low-frequency vibration problems. The Bureau's propagation array data were supplemented by a year's worth of company- and State-collected data. During the year in which the data were collected, the mine employed a variety of blast designs including casting.

This first study was followed by a survey study of eight other Indiana surface coal mines. The objectives of the survey study were to determine if the low-frequency problem was site specific or widespread, how it was related to local geology and specifically sites undermined by old workings, and the importance of the blasting techniques in use.

Test Results

Researchers found that many of the sites had occasionally experienced low-frequency (below 10 Hz) and long-duration (up to 8 seconds) blast vibrations. It was also found that such vibrations could be generated at both undermined sites and those with thick, low-velocity surface layers. Based on traditional methods for calculating charge weights per delay, vibration amplitudes were found to be abnormally high. This finding added to the evidence that the longstanding 8-millisecond minimum separation criterion was not sufficient to separate charges for such low-frequency cases. In addition, vibration frequencies were predominantly determined by the propagating media

(geologic structure, composition, and old mine workings) and were slightly, if at all, responsive to changes in delay intervals. It is significant that these production blasts used standard pyrotechnic initiators with standard delay errors.

Some preliminary tests with experimental precision timing suggests increased control of both vibration characteristics and fragmentation performance. For low-frequency problem sites, this would mean an increased range at which blast design can influence vibration. Sites that were not previously controllable may become so. Widespread availability of precision initiators promises to greatly expand the capability for effective, efficient, and safe blasting.

For More Information

The results of the Bureau's vibrations studies have been published in several Reports of Investigations (RI's)

including RI 8507 "Structure Response and Damage Produced by Ground Vibration From Surface Mine Blasting," RI 8896 "Effects of Repeated Blasting on a Wood-Frame House," RI 9026 "Effects of Millisecond-Delay Intervals on Vibration and Airblast From Surface Coal Mine Blasting," RI 9226 "Comparative Study of Blasting Vibrations From Indiana Surface Coal Mines," and RI 9078 "Low-Frequency Vibrations Produced by Surface Mine Blasting Over Abandoned Underground Mines."

To learn more about these studies or obtain copies of these reports, contact:

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Low-frequency vibrations from surface coal mine production blasts were assessed to develop blast design procedures for vibration control.