ABSTRACT

The primary objective of blasting at surface mines is to achieve optimum fragmentation while ensuring minimum damage to the environment. The common problems of surface mining are oversize and undersize fragments, toe, backbreak, ground vibration, air overpressure, and flyrock. Various blast design approaches such as cratering, single hole test, empirical, field trials, and computer simulations are being used in rock blasting. However, none of the approaches gives a complete solution to the rock blasting problems in Indian mining conditions. An approach called as 'Guided Approach' has been formulated to provide a comprehensive solution to the blast designs at surface mines. This approach is based on the analysis of the data collected to solve a variety of problems at the surface mines with different geomining conditions. This approach considers all the factors that interact and the processes involved in blast designs.

The guided approach consists of ten elements, namely, formulation of the objectives, study of the existing practice, site characterisations, selection of explosives, environmental considerations, determination of blast design parameters, initial design, field trials, assessment of blast performance, and optimisation. It is an integrated approach comprising step by step procedure for the selection of explosives and determination of blast design parameters with regard to the rock characteristics and environmental constraints. The key elements of the guided approach have been discussed in detail. The derived design guidelines have been compared with the other designs and operating practices observed in a wide range of blasting operations conducted in India and abroad. The comparison is used to justify the design rules and to comment on the adequacy or otherwise of these practices.

Site is characterised by considering rock type, compressive strength, density, penetration rate of drilling, block size, blasthole logging, and hydrogeology. Critical review of the existing blasting practice prompts to identify the shortcomings in that practice and to explore the possibility of improving the blast results. The drawbacks in the present practice of selecting explosives in Indian mines are discussed. The practical methods of selection of explosives based on the evaluation of their field performance are illustrated.

The database of ground vibration along with blast details generated during the study is used to predict ground vibration and air overpressure and to derive relationships among various design parameters. Air overpressure levels from the covered and uncovered detonating cords are compared with those from the bench blasting and the methods to reduce the noise are investigated. The measured air overpressure levels from secondary blasting are also...
compared with those from the bench blasting. Besides conventional methods of controlling ground vibration and air overpressure, other measures to control them are presented at which dissipation of explosive energy in creating these hazards is minimum. It is proved that stemming length and powder factor are the critical factors in controlling flyrock.

A methodology has been established for determination of blasthole diameter incorporating the concept of compatibility between blasthole diameter and bench height, environmental constraints, block size in the rock mass, and the overall cost. As the spacing, stemming, and subgrade drilling are derived from the burden, its calculation is very vital. The burden is calculated from the blasthole diameter, bench height, and rock mass properties. A set of equations is derived for the calculation of a new burden from the optimised ones, when there is a change in the hole diameter or in the bench height or in both. In Indian mines, the recommended stemming length is agreeable with that of the international practices. However, it is required that consideration be given to the stemming material and its particle size, and use of blast control plugs in order to prevent the gaseous energy through stemming ejection. To calculate the required powder factor, relationships are derived by considering rock type and its density, and a correction factor for block size. The importance of delay sequence and delay timing using a Sequential Blasting Machine has been discussed and the principal diagrams have been prepared which can be applied to other initiation systems also.

In order to check the validity of the guided approach, it was successfully implemented at three surface mines, namely, Malanjkhand Copper Project, Rampura Agucha Project and Lambidhar Limestone Quarry to solve the problems of boulder formation and excessive toe, ground vibration and air overpressure, and production of under size fragments, respectively. The causes for the problems were identified and objectives were formulated. The existing practices were critically reviewed and guidelines were prepared for modifications in the blast designs. A few suggestions that could not be implemented are also mentioned. Benefits accrued to the mines are highlighted.

The whole work has been divided into various chapters. Chapter 1 and 2 deal with Introduction and Review of Literature. Chapters 3 through 6 describe the guided approach, and Chapter 7 deals with the application and results of this approach. A set of conclusions based on the study and recommendations for the future work have been incorporated in Chapter 8.