

# Optimization of Blasting Parameters of Opencast Mines

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## ABSTRACT

The mining industry is concerned with the extraction of valuable minerals from the earth. In any mining project, drilling and blasting are the first basic operations that are part of an integrated system and impact the results of subsequent operations in productivity and costs. The main objective of fragmentation with explosives is to make the operation as low cost as possible and at the same time keep the technical details in compliance with the safety conditions. This process is achieved by taking of optimization process. In the present study we attempted to evaluate the optimization of blast design by using computer program OPTIMUM BLAST MODEL. The created model is easy to use one, because it can compare explosive performance by keeping the powder factor constant and changing parameters such as drill hole diameter, number of holes and cost of explosives, and consequently make the decision to choose the right type of explosives. This model will definitely give some relief to mine operators and blasting engineers to achieve a better output at a lower cost of mining. Because modern mines require large amounts of explosives throughout the mine's life, the cost of blasting operation can be significantly reduced by reducing the cost of explosives.

**Key Words: Optimization, Drilling, Blasting, Opencast mine, Blast model, Explosives, Machinery.**

## INTRODUCTION

Pre commencement of topic to introduce MINING INDUSTRY, the mining industry plays a prominent role of economy of that county. In mining the fundamental point is to accomplish greatest extraction of minerals keeping in see the ecological, monetary and rent limitations. With the increase of human progress, the essential of various minerals has expanded complex to fulfill this need. In mining industry the mineral resource extracted by both opencast and underground mining. In both cases the extraction is done by loosening the mineral through mainly perform the operations of DRILLING and BLASTING. In India many of the mines are working on with opencast mining and most of the mining operations are performing with drilling and blasting. The opencast working plays a crucial role in mining because of the improved productivity, recovery and safety of mining operation. The topic is OPTIMIZATION OF BLASTING OPERATION. This topic mainly works on the study and evaluation of optimum blast and blasting parameters. In mining industry OPENCAST mining, the DRILLING AND BLASTING is the major unit operation. The BLASTING is an important process which influences directly on loading, hauling and crushing and milling phase. Now-a-days, there are many achievements conducted in research of blasting theory and blasting parameters in mining industry, especially of blasting parameters for improving rock fragmentation and reducing blasting cost. The better result of rock fragmentation is obtained by the process of OPTIMUM BLAST. The blasting efficiency is improved through the reducing of wastage of explosive energy in blasting, less throw of blasted material and reducing of blast vibration resulting in greater degrees of safety and stability to the nearby structures. Optimization means action of making the best i.e. to achieve maximum or

minimum charge of the operating parameters. Optimization of blast is depends on a host of complex factors related to the rock, explosive, initiation, drill-hole parameters and their layout. The present operation is a step in the direction of developing a suitable blast model, with simple methodologies which can be adapted by the mining industry to achieve better blasting results.

## **OBJECTIVES**

The goal of the investigation is to develop a result of optimum blast design through some parameters, as type of explosive, explosive quantity, blast pattern and fragmentation. The main objective addresses towards: 1. To study the drilling methods and their machineries for effective drilling. 2. To understand the blasting parameters to their suitable working conditions. 3. To study the optimization techniques. 4. Design of optimum blast model to our recommendations.

## **Need for study**

Most of the economic mineral deposits occur in association with massive hard rock. These rock masses should be fragmented to obtain the valuables and separate the materials for further processing. This process can be achieved by conducting of DRILLING and BLASTING. But, sometimes these operations cannot give better results because some parameters effects the blasting results i.e., improper design of blast pattern, poor implementation of blast design in field work and poor use of explosives. So, these operations are eliminated with making of better blast design from old ones means optimize the blast designs for better results and improve productivity.

## **Drilling**

In the field of operation, the rock drilling is the first operation accomplished and its purpose is to drill holes or opening of holes, with the accurate dimension and distribution within the rock masses, where the explosive material are kept along with their initiating devices. This operation comes into two forms, rock penetration and rock fragmentation. This operation termed as drilling, cutting, boring, etc. During the process of drilling the rock mass through the drill tool, the first action is percussion; the drill tool penetrates and breaks the rock surface. After the drill tool expands the breakage continual penetration together with the rotation of the drill bit or continual cut by push or percussion force. The drill bit or drill tool penetrates and breaks the rock surface by a thrust force or impact force; this is the basic mechanism of rock breakage by mechanical method.

## **Blasting**

Blasting is the process of breaking of hard rock mass into loose fragments by using explosive compounds. The explosive compounds are placed in the hard rock through drill hole. Sometimes, blasting is also accomplished for removing the overburden from the surface of the earth for excavating a mineral resource through creates an opencast mine. An explosive is a solid or liquid substance or a mixture of substances which, in a short period of time after applying a flame, heat or shock (explosion), the mixture coverts to large volume of gases at high temperature and pressure. The explosive substance may be the mixture of various elements none of which is explosive by itself or a chemical compound. An explosive contains, apart from the explosive substance. The following materials: 1. Combustible material (wood, fibre, charcoal etc.). 2. Oxidation agents (Ammonium nitrate, Sodium nitrate, etc.). 3. Stabilizers (Magnesium and Calcium Carbonates). 4. Antisetting agents (Preventing the caking of salts). 5. Sensitizers (Metallic powders) According to explosives the explosives can be classified into two categories: i. Low Explosives ii. High Explosives

**Low explosives:**

Low explosive means a mechanical mixture of two or more substances. It includes a supplier of fuel and oxygen. When burned, it burns but when confined, it explodes. It burns comparatively slowly and explodes by direct ignition. This gives the shattering effect when the explosion explodes. Low explosive: Gun powder (It is a common and earliest known explosive of low explosives). The constituents of Gun powder are Charcoal 15%, Sulphur 10% and Potassium nitrate 75%.

**High explosives:**

A high explosive is a chemical compound and combines directly with the fuel and oxygen atoms. These explosives are exploding at velocities of 1500 to 8000 m/s and produce large volume of gases at considerable heat and high pressures. These are classified into two categories, depending upon their composition and explode rate: 1) Primary Explosives and 2) Secondary Explosives

**Primary explosives:**

Primary explosives are characterized by their sensitivity to impulses such as weak mechanical shock, spark or flame, the use of which allows the explosive compounds to be easily detonated from the deflection state. These explosives are used in starting devices such as detonators to initiate charges. Examples of these explosives include mercury fulminate, lead azide, lead stiftate, tetra zine and other alloys.

**Secondary explosives:**

Secondary explosives of this type are military explosives such as TNT, RDX, PETN, and Tetrite, and industrial explosives such as nitro-glycerine, emulsion, slurries, water gels, ANFO and other powder explosives. In opencast mining both vertical and inclined holes practiced with the bench face. The holes drilled in a row may be single or multiple. So those two patterns are used, mainly in the opencast mines. They are: a) Single row blasting pattern b) Multi row blasting pattern

**Single row blasting pattern:**

In single row blasting pattern only one row of holes are drilled and charged in a bench face. In this method the hole diameter is more than multi row blasting pattern and consumption of explosive is also more but getting the fragmentation is minimal.

**Recent advancements in drilling and blasting Digital drilling:**

The two new technologies have recently been implemented in drilling, that are computerized drilling and (MWD) measuring while drilling systems. These systems can provide response on the main functions of the drilling. They are: • Correct location and depth of blast holes • Accurate recording of drilling conditions

**Computer aided blast design:**

In the recent past, computer simulation of blasting has made tremendous improvements in explosive efficiency and consistently replaces the trial and error approach to fragmentation. Computer aided programs allow mine operators to examine combinations of explosives and explosive parameters in a very short time. This allows for faster optimization of drilling and blasting patterns and costs, and affects operational procedures, such as minimizing mucking costs by fine breakage, or examining the effect of different explosive parameters on explosive shapes.

The Computer Aided Blast Design Program treats all aspects of the blasting process as input:

- a) Rock properties;
- b) Blast parameters;
- c) Explosive parameters;
- d) Fragmentation parameters.

The computer model requires maximum data input to provide the design for specific operation. This data is separated into three categories with some typical examples as follows:

- 1) Rock mass parameters
  - a) Rock density
  - b) Tensile and compressive strength of rock
  - c) Young's modulus of rocks
  - d) Longitudinal wave velocity
  - e) Poisson's ratio
- 2) Explosives
  - a) Type of explosives
  - b) Strength properties
  - c) Velocity of detonation
  - d) Hole density
  - e) Initiating and delay system
  - f) Explosive cost
- 3) Site factors
  - a) Face height
  - b) Bench width/ length
  - c) Drill hole diameter
  - d) Fly rock range
  - e) Loading and hauling equipment information
  - f) Fly rock range
  - g) Ground vibrations
  - h) Drilling cost per meter

The input information is provided to blast design to achieve the objectives. Mini computers, micro computers or programmable hand calculators are used for designing blasts and there are many programs are available and used.

#### **ANALYSIS OF OPTIMIZATION TECHNIQUES General:**

The optimization of mining process can be accomplished in a variety of methods. They are:

- i. Optimization of drilling efficiency
  - ii. Optimization of explosive and blast
  - iii. Optimization of mine production system
- Optimization of drilling capacity: An improvement in drilling efficiency was achieved by gradually expanding the drilling parameters from the existing parameter for different benches of the mines. The optimum drilling parameters are achieved by studying the rock properties scientifically and analyze the type of explosives for various benches. So with the help of a computer-assisted method or module, 'SABREX' was helpful.

#### **Computer programs for optimum drilling operation:**

The following are the computer programs for performing of optimum drilling operation: • Dialog's program. • Explosives loading design program. • Care program • Program for jumbo drill machine. So, it is concluded that the computer-aided drilling is very useful in achieving high-production goals by increasing drilling efficiency, saving on drilling rate; saving time of drilling cycle and reducing the cost of drilling and the ability to m1ute back in the offensive face.

**Optimization methodology:**

The main priority here is to optimize the cost with the desired product. The equations obtained for the optimization process are derived from the basic data from the mines and best combinations and are taken according to the optimization standards (Seti and Dey 2004). The priority is given to the number of holes and the desired powder factor in the parameters implemented in the method suggested in the present work. Combining these parameters takes into account the energy output of the explosive and the type and density of the explosive. In the present case, since the drill holes are stable and are not as varied as they are based on the available drill machines, this can be taken as input in the process. The size of the fragmentation must be constant according to the customer's need, which varies by the powder factor, so the powder factor must be constant then it becomes the input data. Explosive pricing, which is the driving data, must also be considered as input. According to the optimized models practiced so far; the burden, spacing, height of the bench, and length of the hole are easily correlated with the diameter of the drill hole by some derivative, linear equations. The total cost of charge and configuration per hole can be calculated from all previous data. The constants used in the equations are derived from the field data available from some Indian metal mines and some optimization equations already implemented in coal and metal mines. Finally the optimization method executes the parameters and gives the total cost of the blast operation after use.

**Discussion:**

The mining industry is moving towards a technology-based optimization process. Unit operations such as drilling, blasting, excavation, loading, hauling and crushing are identified as correlated variables in the total cost equation. In the current situation, the main objective of the mining industry is to optimize the cost of mining by using the variables in the cost equation. The improvement, progression and use of inventive mechanizations are vital for the mining industry to be cost effective. The last decade has seen a dramatic improvement in the quality of blasting technology and product performance. Checking instruments, estimation of technologies and computing tools now have the capability to provide a bank of useful information about a wide range of applications.

**CONCLUSION**

The productivity of drilling and blasting operations can be determined in various perspectives, but the "bottom line" is that they should contribute to the best possible overall financial results for the entire mining operation. In this manner, decisions on drilling and blasting operations should be considered in the overall context and should not be based on short-term economic factors in general. In the present work an optimized blast model is created with simple methods that mining industry can follow to compare explosive costs and achieve better explosive results. The model takes into an account the common explosives used by the opencast mine and which is determined by rock properties, density, and other related parameters. The created model is user-friendly because it can compare explosive performance by keeping the powder factor constant and changing parameters such as drill hole diameter, number of holes and cost of explosives, and consequently make the decision to choose the right type of explosives. It can be noted here that this model was created dependent on contextual investigations of various mines of limestone ore and can be modified with data collection from a large number of mines. This model will definitely give some alleviation to mine operators and blasting workers to achieve a better product at a lower cost of mining. Because modern mines require large amounts of explosives throughout the mine's life, the cost of blasting operation can be significantly reduced by reducing the cost of explosives.

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