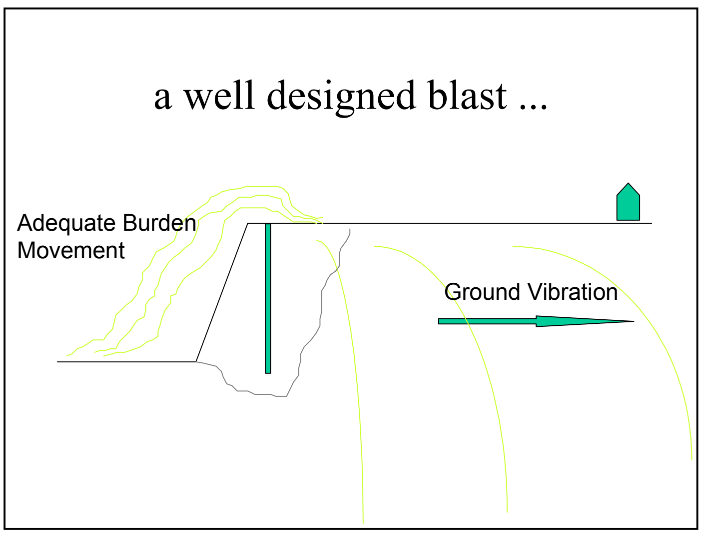
Quarry Blasting: Metal, Non-Metal Mining

In the world today a large percentage of the material used for construction is obtained through a mining or quarrying process. Typically, if a material cannot the grown, it must be mined. The different types of open pit mining are

1. Aggregate quarry
2. Non-metal open pit mine
3. Metal open pit mine.

The geology of the region is the major factor determining the type and design of blast in required to extract the material. Most metal and no-metal mines must remove material that is over or on top of the primary mineral to be recovered. This over burden removal must in many cases be extracted in the same way the primary material is obtained. Drilling and Blasting is by far the most economical means to fragment and move material. The initial blast design depends mainly on the hardness of the rock, the geologic structure of the rockmass, the location of the mine relative to vibration sensitive structures, available drilling equipment and the excavation rate and capacity of the mining equipment. A high level of field controls must be continuously maintained in order to gain reliable quantitative data that can then be used to refine the blast design.



To begin, a well-designed blast consists of a quantity of explosives placed into a series of blast holes drilled into a rockmass. The amount of explosive energy generated by the explosives must be adequate to overcome the tensile strength of the rockmass. This series of blastholes must then be detonated in a controlled sequence as to control the burden and spacing dimensions between adjacent holes. A well-designed blast will efficiently utilize the explosive energy in order to result in optimum fragmentation and burden movement. One of the negative impacts of blasting is ground and air vibration. Proper burden spacing design dimensions maintained through accurate field controls typically will yield reduced ground vibrations as the energy is used to fragment and move rock and **not** to create excessive ground vibrations through energy over-confinement.

The mining design must always be considered during the initial blast design and refinement to provide site specific optimized performance as site conditions change. The proper type and controlled amount of explosive energy evenly distributed into the rockmass are the keys to optimized blast design. It is recommended that at least 60% of the borehole be loaded with explosives. The safe amount of explosives to be used is usually determined or based on the vibration sensitivity of the area. There is a relationship between the energy level of the product, the energy confinement and the blast induced vibration levels. The accepted amount of explosives to be utilized per hole must then be distributed evenly throughout the rock based on the hole diameter, bench height and stemming requirements to control excessive flyrock. The energy confinement factor quantifies the relationship between the hole diameter, the stemming column height and the explosive.

Reducing the hole diameter is usually the best way to increase the energy distribution of the explosive higher into the rockmass without increasing the flyrock potential of the blast. The relationship between the hole diameter and the bench height must then be considered to determine the appropriate burden and spacing dimensions.

The burden and spacing dimensions must also consider the characteristics of the rockmass. A highly jointed strata usually requires that the pattern be kept tighter so the fragmentation can be more controlled by the explosive energy than the pre-existing structure of the rock. A more massive or homogenous rock formation will permit the expansion of burden and spacing dimensions as the fragmentation is not governed by a pre-fractured joint system.

Shorter periods of time between rows will typically result in a more stacked up muckpile. This is a more favorable scenario for an operation that uses rubber tired loaders to excavate the rock.

The accumulated downstream costs associated with the extraction and processing of construction aggregates, metals, or non-metal minerals will always be highly controlled by the overall blast performance as it relates to fragmentation. It is always more economical to crush rock in the pit with the use of chemical explosive energy than it is to crush rock with electric motor driven mechanical crushing systems.

The advent of electronic detonators is providing for a high level of blast optimization never before realized. After the proper blast geometry and loading parameters have been optimized, the precise control of detonation times between adjacent holes and rows is the major influence of rock fragmentation. There are several theories as to the proper way to time a production blast for maximized rock fragmentation. Current studies quantifying the results of quarry blasting utilizing electronic detonators is confirming the added benefits of accurate timing as it relates to fragmentation, excavation costs, crushing costs, and the prediction and control of blast induced ground vibrations.

Unlike the coal and single pass quarries that backfill the open pit as the mine follows the mineral seam or deposit, specialized blasting techniques must oftentimes be utilized in multi-level open pit quarries that must maintain long lasting and competent final walls. These final walls are in many mines crucial to the existence of the mine as the deeper levels are developed.

Slope stability is necessary to provide safe conditions for mining activity below. The blasting program must include methods for wall control and final wall stability. These methods are again techniques to control the path of least resistance of explosive energy. Overly confined energy levels typically precondition a rockmass by establishing micro-fractures into the rock that extend far beyond the designed area of influence. This over break phenomena is usually the main source for premature deterioration of a final wall. The most common method to provide for competent final walls is known as pre-split blasting.