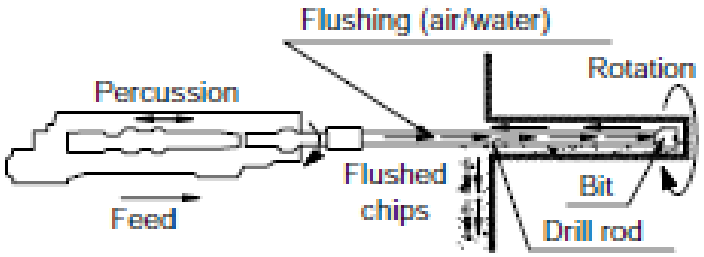
Drilling

Drilling or boring is a prime operation in the excavation technology without which exploration, development, exploitation and liquidation of mineral deposits could not succeed.

The purpose of drilling (rock penetration) in mining operations is to create small or large diameter holes in the rock massive for the placement of explosives in order to loosen and fragment the material for subsequent operations.

Operating components of the drilling system

There are four main functional components of a drilling system, working in the following manner to attack the rock as illustrated in figure below.



(d) Principle of percussive drilling

1. ***The drill***: it acts as prime mover converting the original form of energy that could be fluid, pneumatic or electric into the mechanical energy to actuate the system.

2. ***The rod (or drill steel, stem or pipe)*****:** it transmits the energy from prime mover to the bit or applicator.

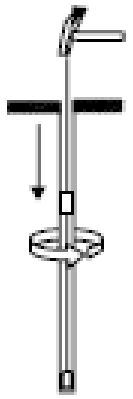
3. ***The bit***: it is the applicator of energy attacking the rock mechanically to achieve penetration.

4. ***The circulation fluid*****:** it cleans the hole, cools the bit, and at times stabilizes the hole. It supports the penetration through removal of cuttings. Air, water or sometimes mud can be used for this purpose.

Mechanics of rock penetration

Top-hammer drilling

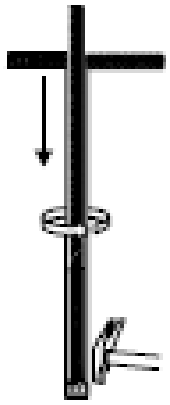
In this system the top-hammer's piston hits the shank adapter and creates a shock wave, which is transmitted through the drill string to the bit.



Top hammer drilling

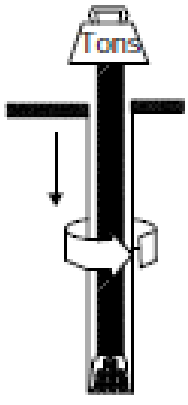
Down-the-hole (DTH) drilling

In this system the down-the-hole hammer and its impact mechanism operate down the hole. The piston strikes directly on the bit, and no energy is lost through joints in the drill string .



Rotary drilling

Rotary crushing is a drilling method, which was originally used for drilling oil wells, but it is now days also employed for the blast hole drilling in large open pits and hard species of rocks. In rotary drilling energy is transmitted via drill rod, which rotates at the same time as the drill bit is forced down by high feed force.

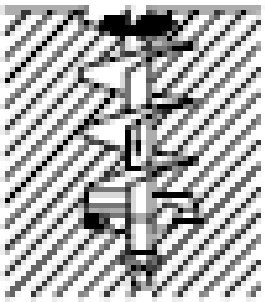


Rotary drilling

All rotary drilling requires high feed pressure and slow rotation. The relationship between these two parameters varies with the type of rock. In soft formations low pressure and higher rotation rate and vice versa, are the logics usually followed.

Augur drill

The augur drill (fig. 4.2(c)) is the simplest type of rotary drill in which a hallow-stem augur is rotated into the ground without mud or flushing. The continuous-flight augurs convey the cuttings continuously to the surface. This also works on the rotary cutting principle.



Augur drilling

Motive power of rock drills

In addition to the above-mentioned basis, there are several other ways to classify the rock drills. Depending upon the motive power they can be classified as pneumatic, electrical and hydraulic rock drills, as illustrated in figure.

Figure Rock drills' classification based on their motive power.

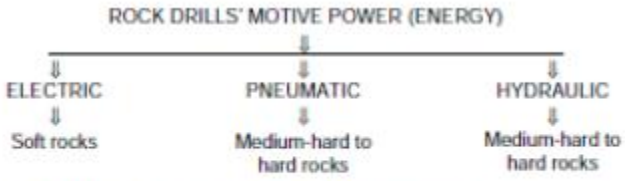


Figure Rock drills' classification based on their motive power.

Selection of drill

Drill selection:

Drill selection for a particular application should be based on the technological and cost factors.

It is considered that the lower cost is obtainable in soft rock with rotary drag-bit drilling, in medium and hard rock with rotary roller-bit and rotary-percussion drilling, and in very hard rock with percussion drilling.

Use of percussive drills is very common in underground metalliferous mines and tunnels.

The rotary drills are common in underground coal mines. In surface mines both types of drills have applications depending upon the rock types.

***Drilling efficiency*:**

Drilling efficiency can be measured by taking into consideration the following parameters:

- By the manner in which the drilling tool i.e. the drill acts upon the hole bottom (percussive, rotary or percussive rotary)
- The forces and the rate with which the drilling tools act upon the hole bottom
- Hole diameter and its depth
- The method and speed with which the drilling cuttings are removed from the hole.

These factors determine a type of drill required to suit a particular type of rock, as drillabilty of rocks differs widely.

Using of Drilling

The drilling used in mining for various purposes:

- For underground mining;
    - vertical development (Shaft, raises, slopes)
    - Horizontal development: (tunnels, rumps,drives)
    - Stop preparation
    - Stopping (Ring, holes, fans)
- For surface mining:
    - Quarries
    - Open pit
    - Open cast
- Also it used for controlled blasting holes to reduce over break.

Blasting

Blasting is an important part of mining cycle. Blasting technology is the process of fracturing material by the use of a calculated amount of explosive so that a predetermined volume of material is broken. Blasting is used in both open pit and underground mining operations.

The major objectives of blasting are

- fragmentation and
- rock displacement.

The variables that affect blasting are:

- Rock mass properties (Rock type, density, and strength)
- Explosive properties
- Blast geometry, angles of the blast holes towards free face
- Initiation

Rock blasting

In commercial blasting, energy released by a detonation results in four basic effects:

- Rock fragmentation
- Rock displacement
- Ground vibration
- Air blast

Classification of Explosives

Explosives have wide applications in mining and tunneling operations to carryout rock fragmentation for the differing conditions; hence, a wide range of this product is available. Given below is the general classification of explosives.

- **Primary or initiating explosive**

Primary explosives may be defined as those explosive substances, which respond to stimuli like shock, impact, friction, flame etc. and pass from the state of Deflagration (a high rate of burning) to detonation. Generally used in Detonators

- **Secondary explosives**

These are the explosive substances, which are capable of detonation, created by a primary explosive. Thus these explosives have a high rate of detonation and initiated by the primary explosives.

- **Pyrotechnic explosives**

Pyrotechnic compositions are used as a delay element in the manufacturing of the detonators.

- **Low explosives**

The earliest known explosives belong to this class. These are commercially known as gun powder or black powder.

- **Commercial explosives – High explosives**

There are the explosive substances, which can't be initiated easily by the stimuli such as impact, friction or flam but with application of a shock pressure or a detonation wave, (eg) TNT, Nitroglycerin (NG) and slurry explosive.

Blasting properties of explosives

Each explosive has certain specific properties or the characteristics.

Given below are **some** of the important properties, which influence the ultimate choice of an explosive.

- **Strength**

  It is the energy released/unit weight (known as weight strength); or per unit volume (known as bulk strength) of an explosive.

- **Detonation velocity**

It is the velocity with which the detonation waves move through a column of explosives.

- **Density**

  The explosives' density is in the range of 0.5 to 1.7. A dense explosive release more energy/unit volume, hence it is useful for the hard and denser strata.

- **Water resistant**

  A practical way to judge the ability of any explosive to resist water is its capability to withstand exposure to water without losing sensitivity or efficiency.

- **Fume characteristics, or class, or medical aspects**

  An explosive after blasting should generate minimum amount of toxic gases such as carbon mono oxide, oxides of nitrogen etc.

- **Borehole pressure and critical diameter**

  It is an important parameter, which measures the breaking and displacement property of an explosive.

- **Safety in handling & storage qualities**

Ore handling

Ore handling, which may account for 30-60% of the total delivered price of raw materials, covers the processes of transportation, storage, and feeding of the ore.

In underground mines ore transport has either been by locomotive-hauled mine car, belt conveyer or rubber tired trucks. The transport of persons, materials and equipment has either been by rail- mounted truck system or trackless system/movable vehicles.

The consideration of transport system for ore, persons, materials, and equipment are *major factor in the decision to use drift and/or shaft for a mine*.

There are many mines using a shaft for persons, materials and equipment transport.

Inclined shaft *are often* used for belt conveyer transport

Cage function is to transport of person and materials to and from underground.

Skips are shaft conveyer for hoisting ore or waste from underground.

In surface mines, the handling of materials and ores depends on;

- the volume, size, weight and type of ores**.**

Conveyer belt; used for transport materials with limited volume and size, and depend on type of ore. Mud and sand can't be transported by conveyer belt. The belt conveyors having their applications both for surface as well as underground mines.

Rail track; used for transport materials and equipment.

Gravity bucket elevators; Where space limitation does not permit the installation of a belt conveyor, gravity bucket elevators can be used. These provide only low handling rates with both horizontal conveying and elevating of the material.

Pipes; in plants of any size, the pulp is moved through piping via centrifugal pumps. Pipelines should be as straight as possible to prevent abrasion at bends. The use of oversize pipe is dangerous whenever slow motion might allow the solids to settle and hence choke the pipe.

The factors involved in pipeline design and installation are complex and include

- the solid-liquid ratio,
- the average pulp density,
- the density of the solid constituents,
- the size analysis and particle shape, and
- the fluid viscosit