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.”

Younus Ahmed Khan

Drilling

Production cycle during Tunneling (or mine development) = *shot hole drilling + blasting + mucking + hauling + hoisting (optional)*

Similarly,

Production cycle during stoping operations in mines, or Large excavations in civil and construction projects = *blasthole drilling + blasting + mucking + hauling + hoisting (optional)*

The drilling with few exceptions such as: exploration, to provide drainage, in fixing rock bolts, in stabilizing slopes and to test foundations, is employed in mining and tunneling for placement of explosives.

Drilling- A purpose of Rock Breaking

Primary rock breaking

Detaching the large rock mass from its parent deposit is known as rock breakage.

Blastholes:

Application of explosive in the rock is carried out by means of drilling holes, which are known as *shot holes, blastholes or big blastholes* depending upon their length and diameter.

Holes of small diameter (32–45 mm) and short length (upto 3 m) are termed as *shot holes, and they are drilled during tunneling and* drivage work in mines.

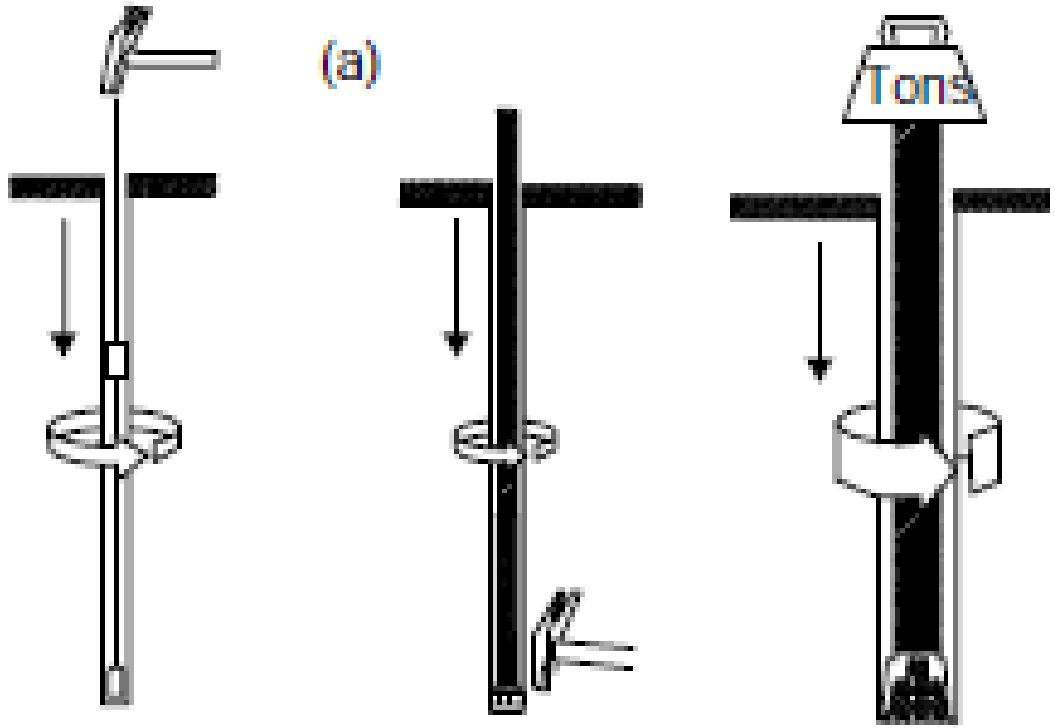
The *blastholes are longer (exceeding 3 m to 40 m or so) and larger* in diameter (exceeding 45 mm to 75 mm or so), and that are drilled as cut-holes in tunnels and drives, and in the stopes

- Recently use of very large diameter (exceeding 75 mm) long holes, known as *big blastholes, have begun for* the raising and stoping operations in underground mines too.
- Thus, to dislodge or break the rock from its rock-massif use of suitable drills, explosives and blasting techniques, is made.

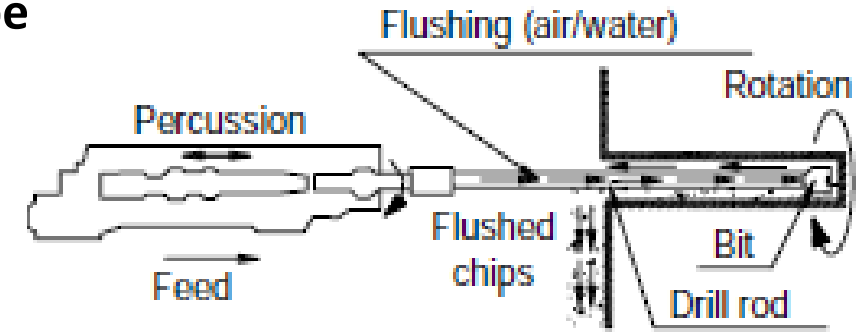
Operative components of a drilling system

There are four main functional components of a drilling system, working in the following manner to attack the rock:

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.


(a)
Tons
Top hammer drilling
Down-the-hole drilling
Rotary drilling
(b)
(c)
Rotary crushing
Rotary cutting
Augur drilling

Percussive type



(d) Principle of percussive drilling

Top hammer drilling

Working principles:

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 (fig. a)

The energy is discharged against the bottom of the hole and the surface of the rock is crushed into drill cuttings.

These cuttings are in turn transported up the hole by means of flushing air that is supplied through the flushing hole in the drill string. As the drill is rotated the whole bottom area is worked upon.

The rock drill and drill string are arranged on feeding device. The feed force keeps the drill constantly in contact with the rock surface in order to utilize the impact power to the maximum

Top hammer drilling

Cost effectiveness
low energy consumption and investments on drill-strings

Hole diameter
In surface mines and civil construction sites 76–127 mm (3–5) hole diameters is the usual range

Down-The-Hole (DTH) drilling

Working Principles

This is very simple method for the operators for deep and straight hole drilling
Hammer works down-the-hole 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.

The drill tubes (rods, steels) convey compressed air to the impact mechanism and transmit rotation torque and feed force.

The exhaust air blows the holes and cleans it and carries the cuttings up the hole.

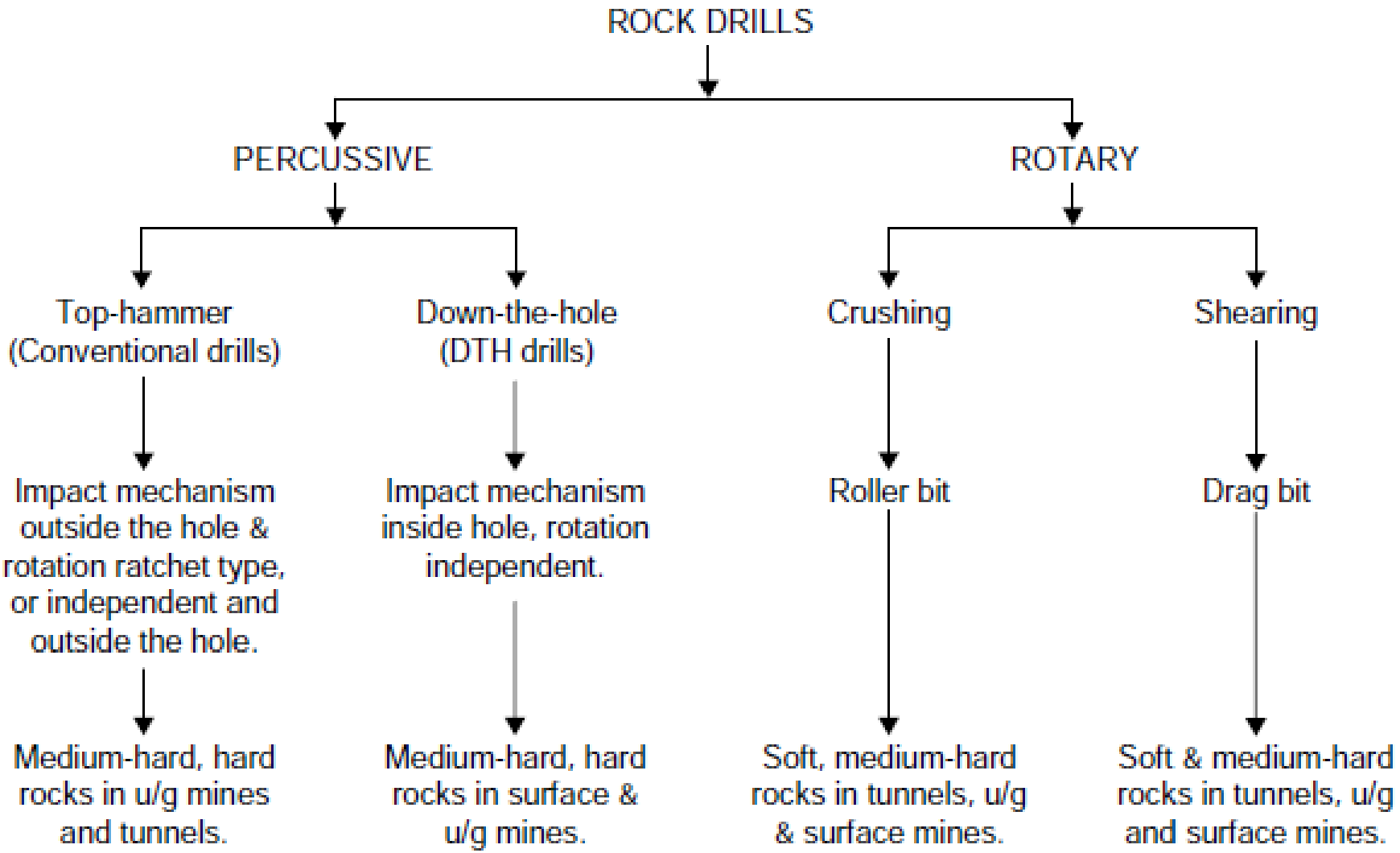
Known by various trade names such as ‘down-the-hole drill’, ‘in-the-hole-drill’

Down-The-Hole (DTH) drilling

The DTH drill follows immediately behind the bit into the hole, rather than remaining on the feed as with the ordinary drifters and jackhammers. Thus, no energy is dissipated through the steel or couplings, and the penetration rate is nearly constant, regardless the depth of the hole.
Since the drill must operate on compressed air and tolerates only small amounts of water, cuttings are flushed either by air with water-mist injection, or by standard mine air with a dust collector.

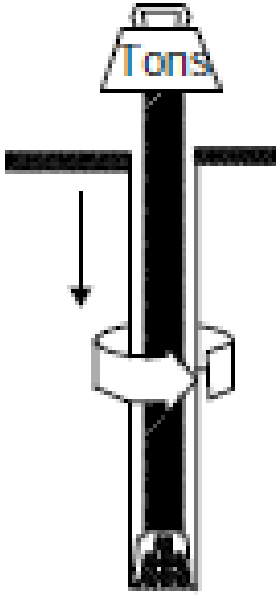
Hole diameter
In surface mines 85–165 mm (3.4–6.5) hole diameters is the usual range.

Rock drills classification based on application of mechanical energy to rock.



Rotary drilling

Rotary drilling 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. It is used for a rock having the compressive strength upto 5000 bar (72,500 psi).

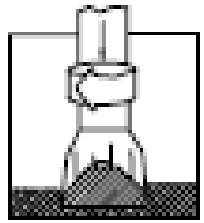


Rotary drilling

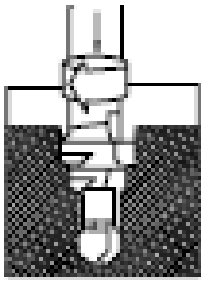
Working principles

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

All rotary drilling requires high feed pressure and slow rotation.
In soft formations low pressure and higher rotation rate and vice versa
In general, if the rock hardness is less than 4.0 on Moh's scale, the rotary drilling has the advantages, except when the rock is abrasive.
The rotary drills can be operated using either compressed air or electrical power.
When drilling is done by *rotary crushing method, the energy is transmitted to the*
drill via a pipe which is rotated, and presses the bit against the rock


Rotary crushing

When drilling is done *by rotary cutting method the energy is transmitted to the insert* via a drill tube, which is rotated and presses the inserts against the rock. The edge of insert then generates a pressure on the rock and cracks off the chips


Rotary cutting

Rotary drilling

Advantages

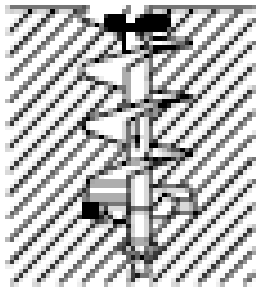
It is unbeatable in difficult drilling conditions, as it gives high productivity and good penetration rates in such conditions.

Hole size

In surface mines and civil construction sites 90–165 mm (3.5-6.5) hole diameters is the usual range.1

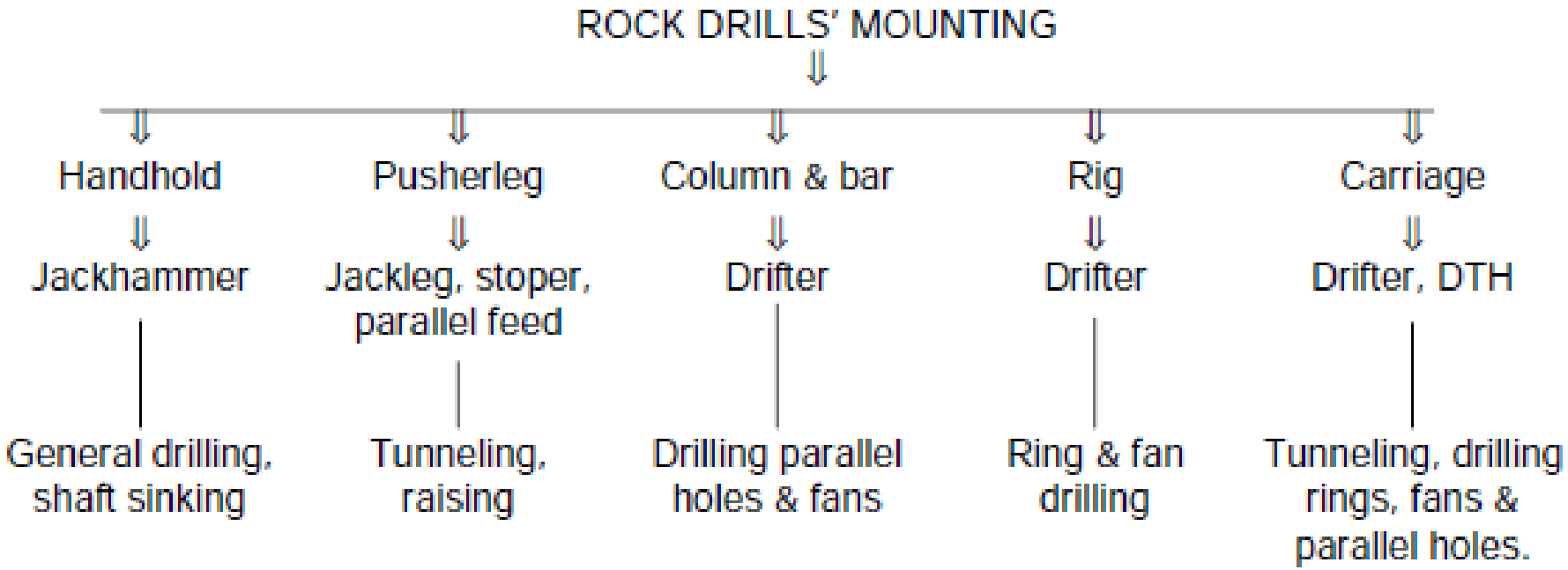
Augur drilling

The augur drill 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

Rock drills classification based on their mountings



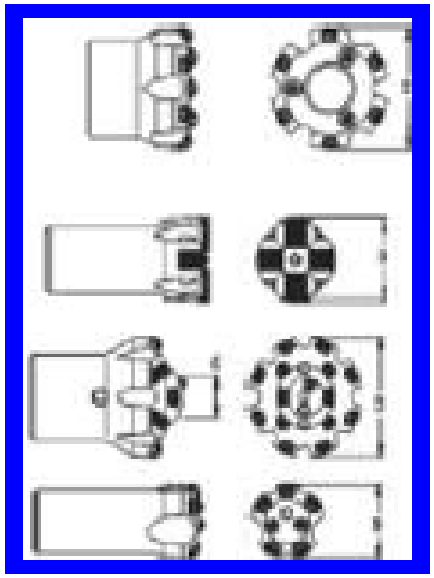
In order to meet the variety of conditions encountered in rock drilling several distinct types of drills have been developed

In general, rock drills may be classified as either hand held or mounted

The hand held drills include an electric drill, jackhammer, jackdrills or jacklegs and Stoper

The mounted drills are known as 'drifters'

Common drilling accessories used during development drifting, raising and tunneling operations



Reaming bits

Cross bit
35 – 51 mm

Button bits
33 –127 mm

Drilling accessories

Drilling accessories – integral drill steels, bits – cross, button, and x types; couplings, shank adopter, extension rods, etc.