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Development

Introduction

Mine Development contains the following:

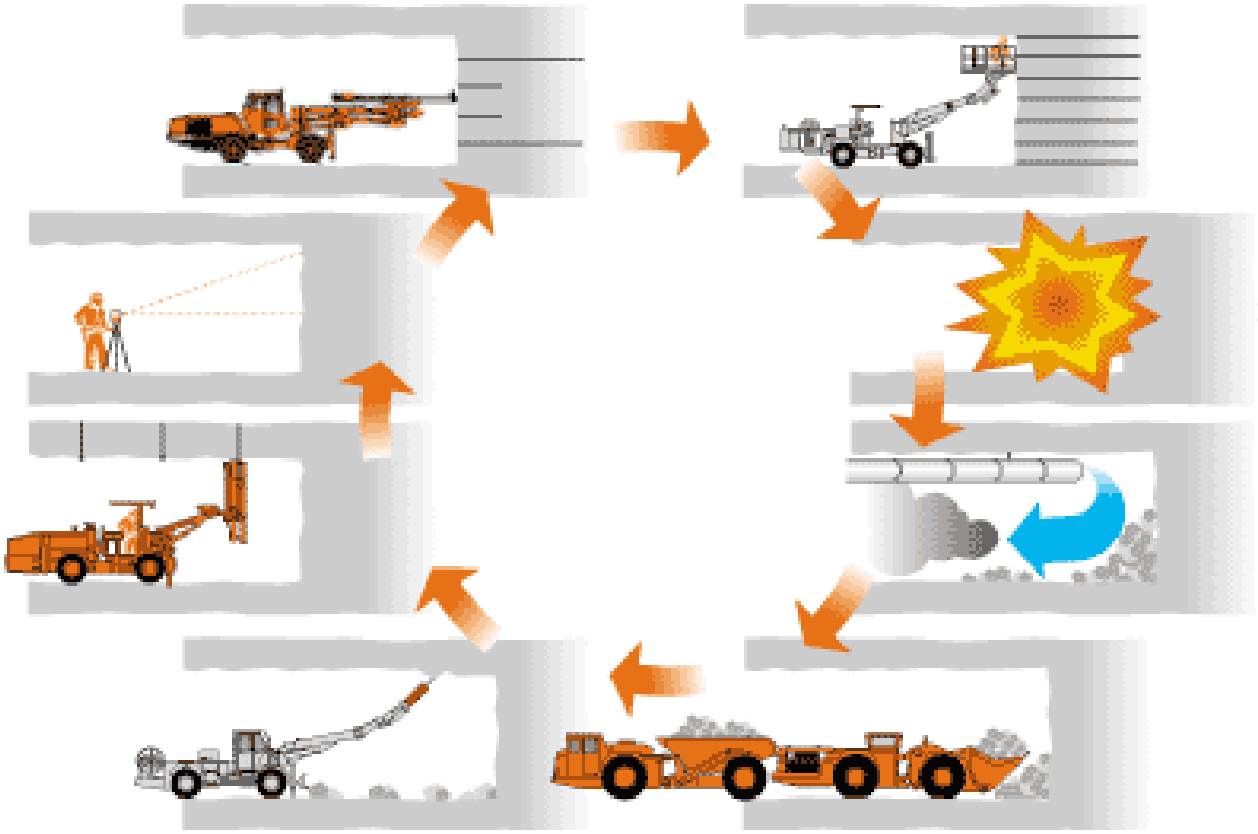
- Drilling Large Deposits
- Drilling Small Deposits
- Development Shafts and Adits
- Blocking Out Ore
- Access
- Power
- Communications
- Site Preparation
    - Mine
    - Mill
    - Town Site

Underground Mining Development

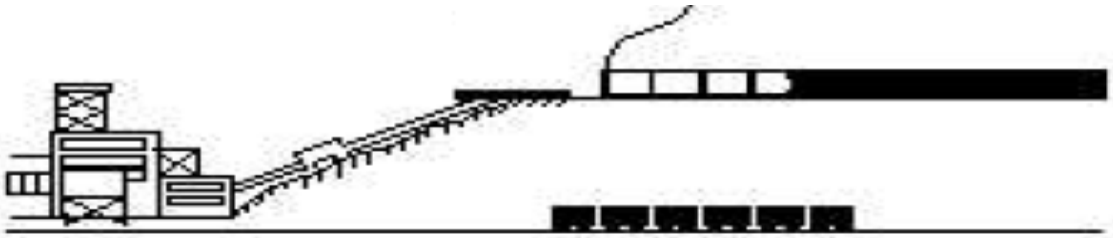
(Mechanized Drift or Tunnel Development)

Basic drilling cycle for drill and blast drifting and tunneling:

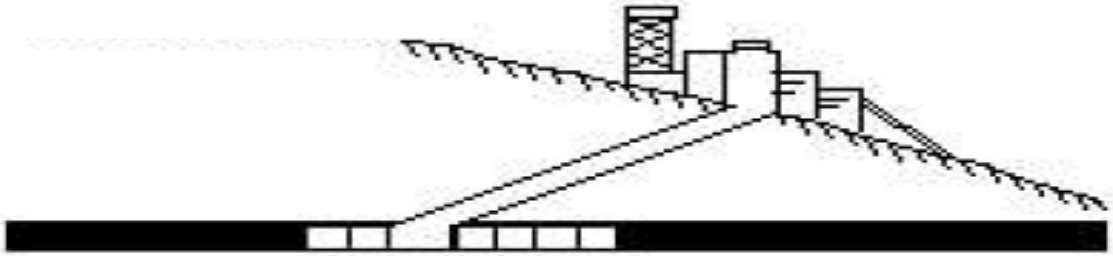
- Surveying and setup
- Drilling
- Charging
- Blasting
- Ventilation
- Scaling
- Mucking
- Scaling
- Bolting



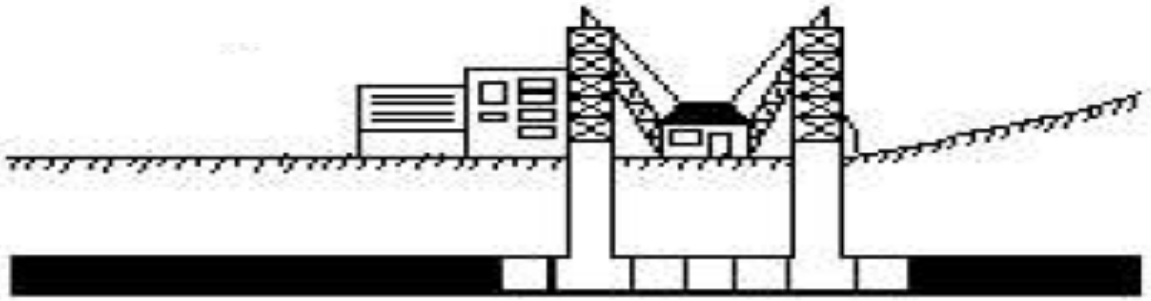
Different Access to Ore Bed



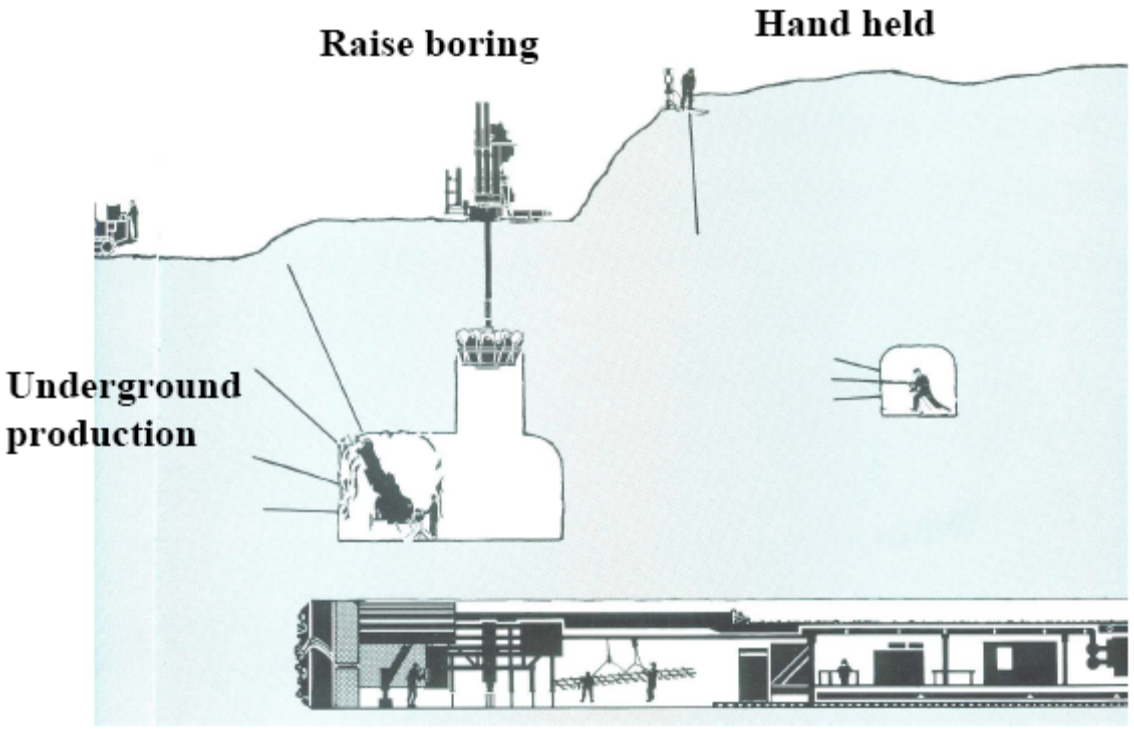
Slope Mine

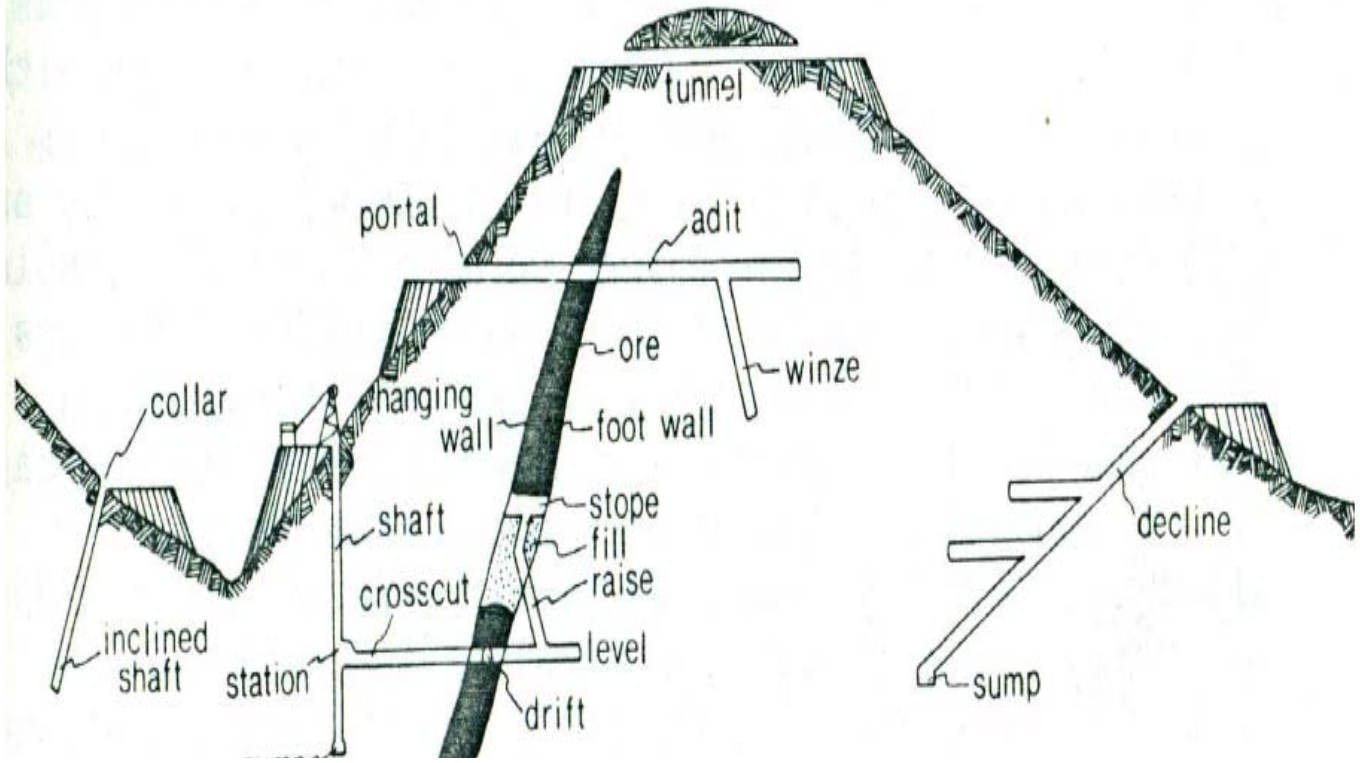


Drift Mine



Shaft Mine


Raise boring
Hand held
Underground production
Tunnel boring


tunnel
portal
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foot wall
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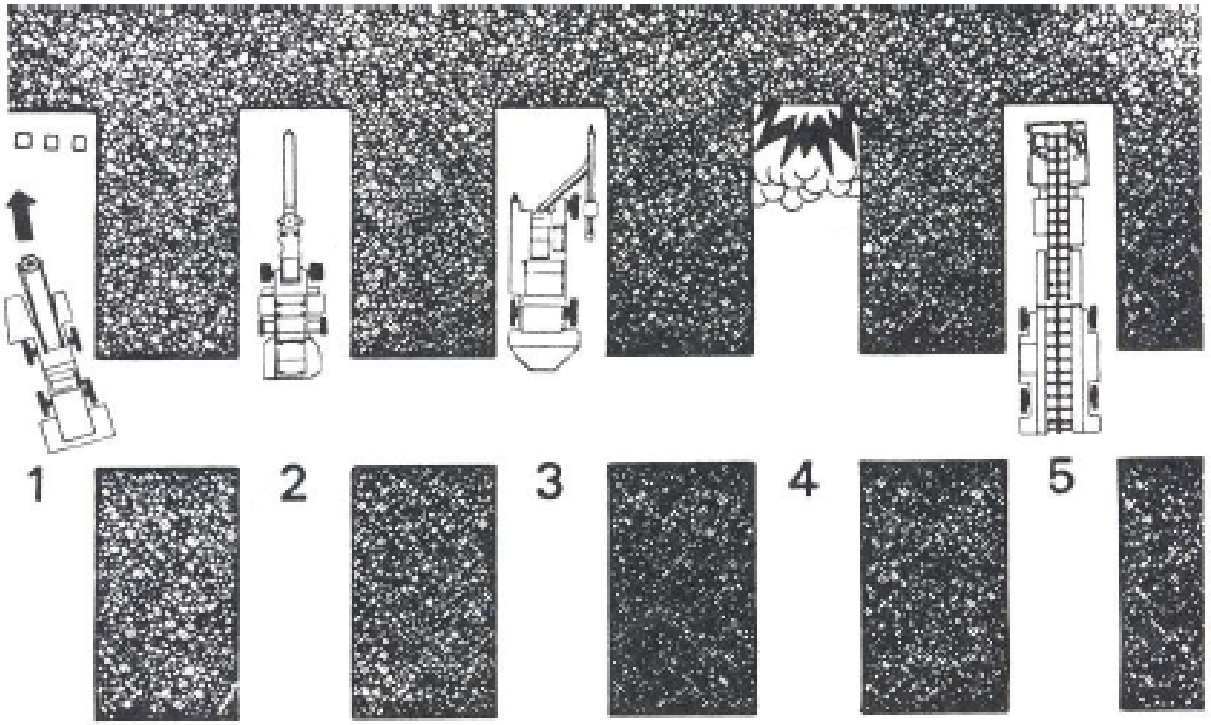
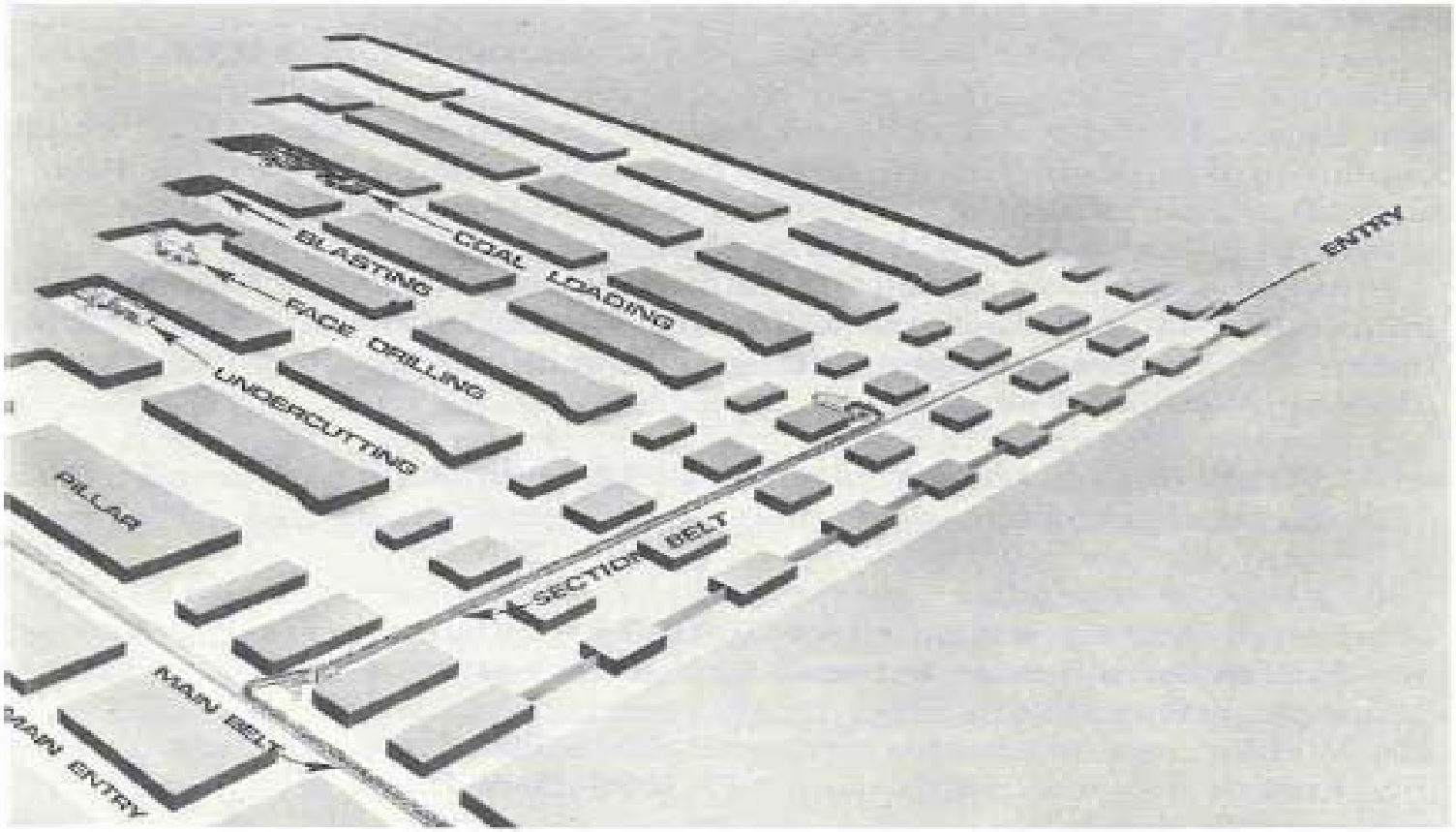
fill
raise
crosscut
level
inclined
shaft
station
drift
decline
sump

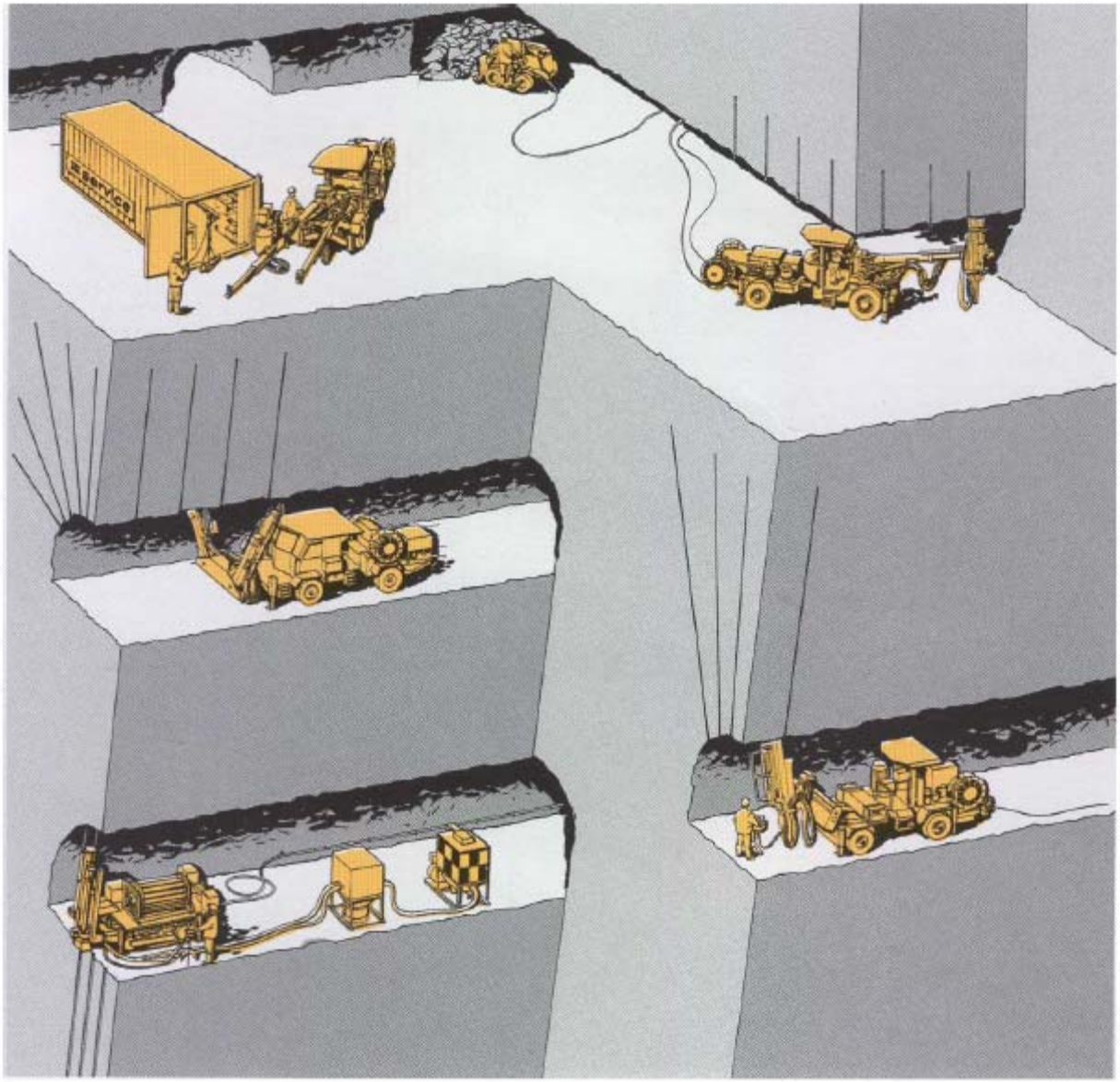
Mining Cycle

1. Roof bolting
2. Undercutting
3. Drilling
4. Blasting
5. Loading

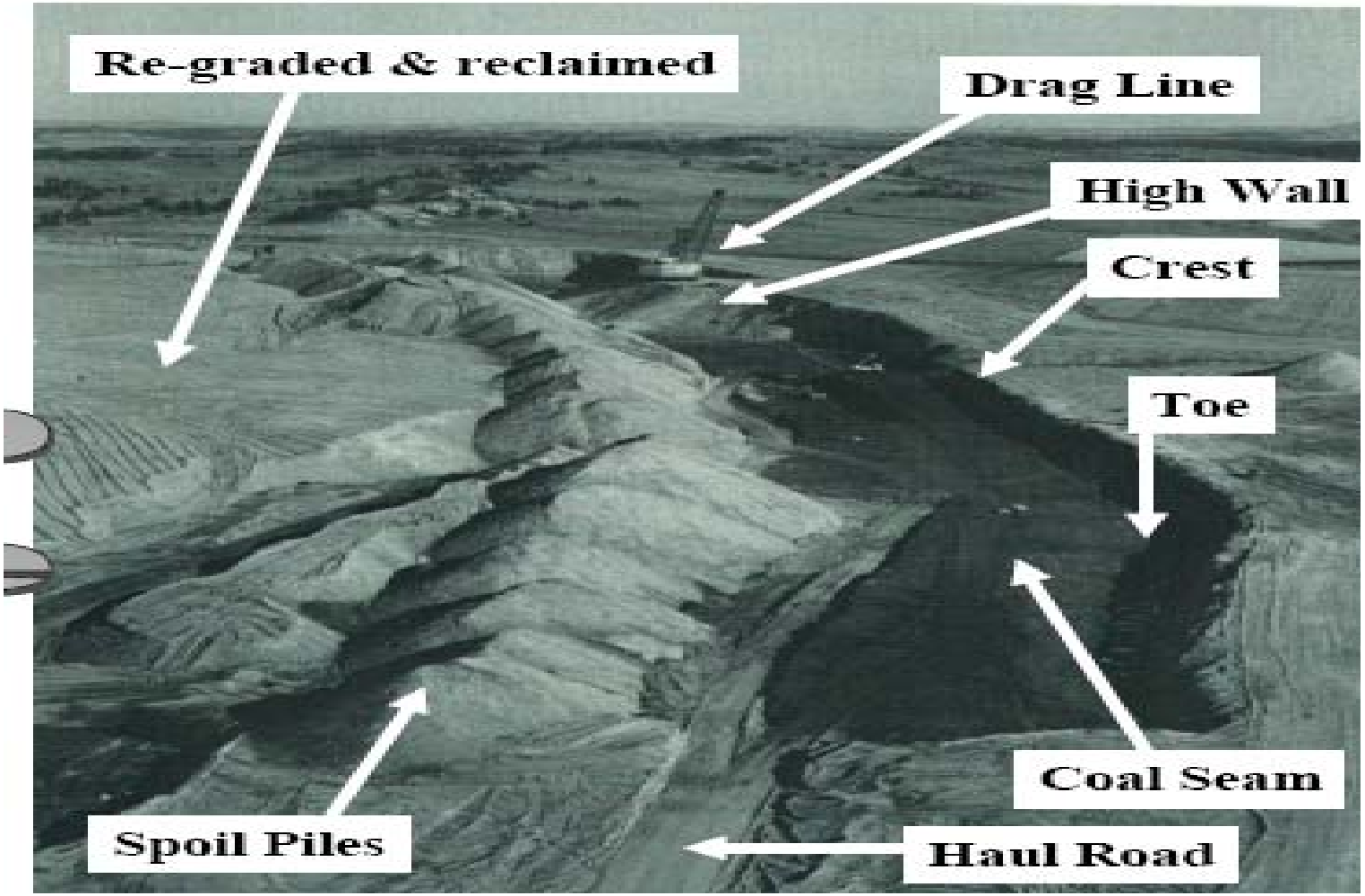


Some Examples




Service

Surface Mining Development



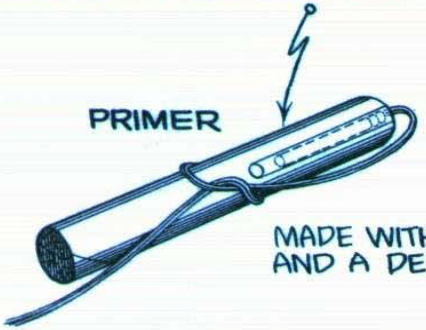
Blasting in Underground Mining

Eplosives

PRIMERS

THE BOREHOLES MADE FOR DEVELOPMENT BLASTING ARE LOADED WITH AN EXPLOSIVE - EITHER AN/FO OR A STICK TYPE. IN EITHER CASE, THE EXPLOSIVE REQUIRES A PRIMER OR BOOSTER FOR DETONATION. THE PRIMER MUST BE PLACED IN THE BOREHOLE FIRST - THEN THE REMAINDER OF THE HOLE IS FILLED WITH THE TYPE OF EXPLOSIVE BEING USED.

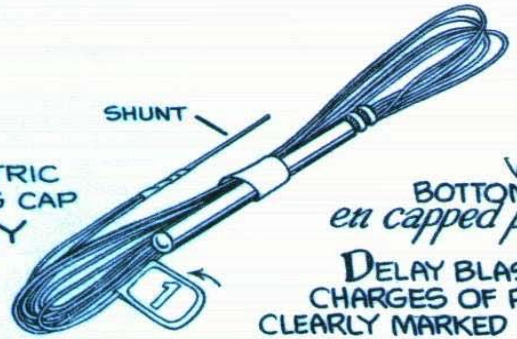
THERE ARE SEVERAL DIFFERENT TYPES OF PRIMERS - AN EXAMPLE IS SHOWN HERE.



MADE WITH STICK POWDER AND A DELAY CAP

ELECTRIC CAPS, PRIMADETS, ETC. ARE TO BE CARRIED ONLY IN THE BOXES WHICH ARE SPECIALLY BUILT FOR THIS PURPOSE. ANY THAT ARE NOT USED ARE TO BE RETURNED TO THE POWDER MAGAZINES IMMEDIATELY.

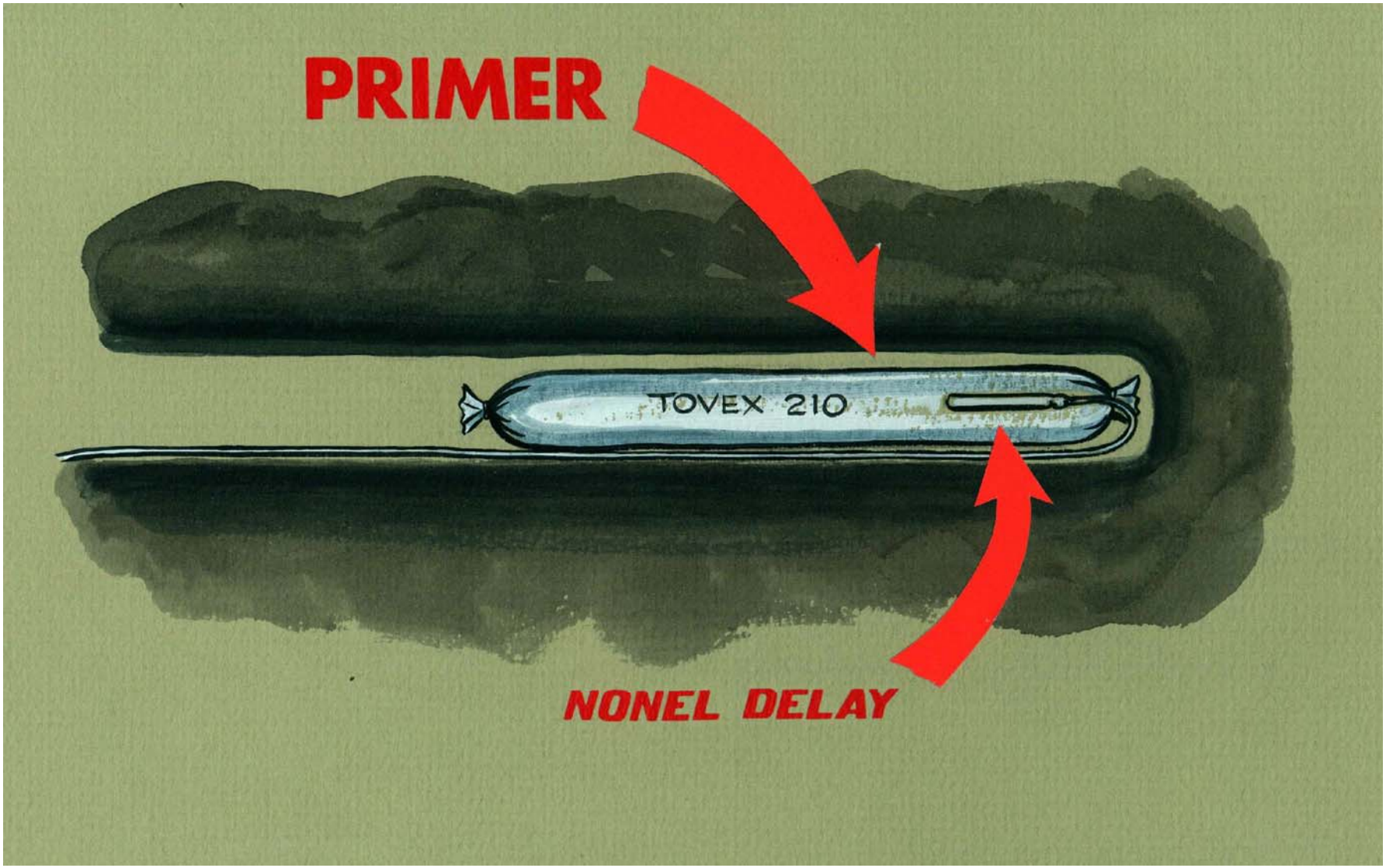
PRIMACORD, AN/FO, AND POWDER CAN BE CARRIED TOGETHER
– DO NOT CARRY BLACKWICK AND EXPLOSIVES TOGETHER.



BEFORE LOADING THE BOREHOLES WITH AN/FO OR STICK POWDER, THE DELAY LEG WIRES OR TUBES ARE UNWOUND AND PRIMER IS INSERTED AND SHOVED TO THE BOTTOM OF THE HOLE. *use only a wooden stick, a wooden capped plastic pipe, or the plastic AN-FO loading hose.*

DELAY BLASTING CAPS ARE USED IN PRIMERS TO SET OFF CHARGES OF POWDER IN SUCCESSIVE ORDER. EACH DELAY IS CLEARLY MARKED IN SERIES FROM 1 THROUGH 10. THEY ARE TO BE PLACED IN ORDER TO MEET ROUND BLASTING SPECIFICATIONS.

***BE SURE** THERE ARE NO KINKS IN THE DELAY TUBE OR WIRES WHEN PUSHING THE PRIMER TO THE BACK OF THE HOLE.*

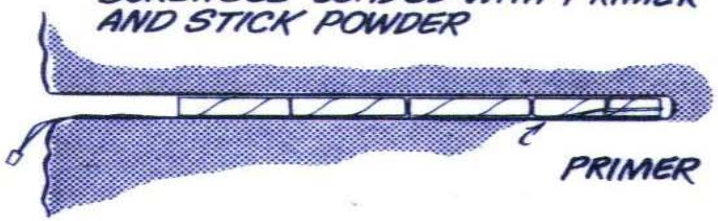

PRIMER
TOVEX 210
NONEL DELAY

EXPLOSIVES ..... AMMONIUM NITRATE / FUEL OIL (ANFO)

A COMPARATIVELY NEW TYPE OF EXPLOSIVE, AMMONIUM NITRATE IN FERTILIZER FORM COMBINED WITH FUEL OIL, HAS BEEN INTRODUCED TO THE MINING INDUSTRY TO SUPPLEMENT THE USE OF DYNAMITE FOR ROCK BLASTING.

- AS USED HERE **ANFO** IS SUPPLIED IN A PELLET FORM CALLED "PRILLS"... AND IS CONTAINED IN 50 lb. BAGS.
- BECAUSE OF ITS LOW DEGREE OF SENSITIVITY ---- (ORDINARY BLASTING CAPS MAY NOT DETONATE IT) IT IS MUCH SAFER TO HANDLE THAN DYNAMITE; HOWEVER, SINCE THE PROPERTIES OF ANY EXPLOSIVE MAY BE UNPREDICTABLE, ALL PERSONS WORKING WITH **ANFO** SHOULD TREAT IT AS A HIGH EXPLOSIVE.
- ALL THE SAFETY RULES FOR BLASTING IN GENERAL ALSO APPLY TO THE USE OF AMMONIUM NITRATE.

BOREHOLE LOADED WITH PRIMER AND STICK POWDER



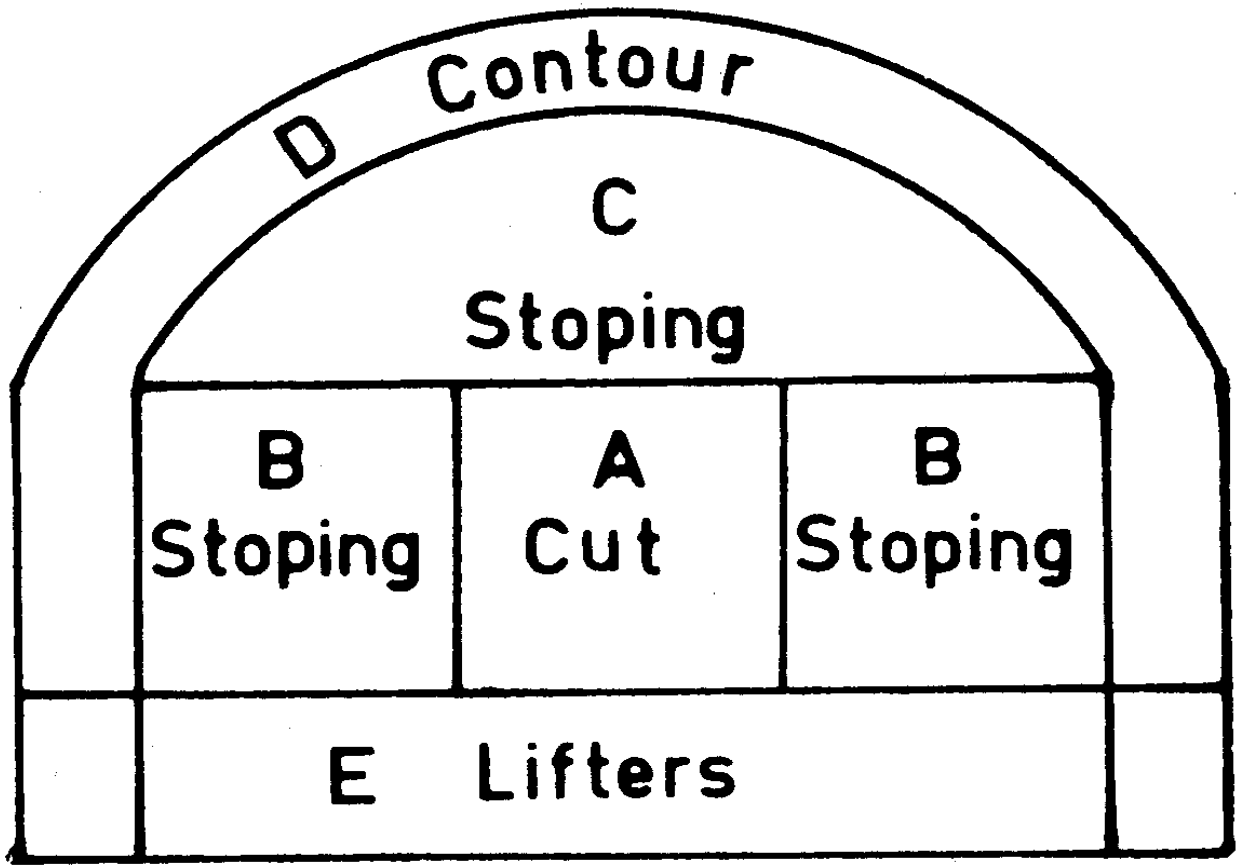
BOREHOLE LOADED WITH PRIMER, OR BOOSTER AND A.N. PRILLS.

PRIMER
(STICK OF POWDER)
OR
MARTIN BOOSTER
and a
HIGH STRENGTH
BLASTING CAP

THE EXPLOSIVE PROPERTIES OF **ANFO** AND STICK POWDER ARE SIMILAR. THE TWO METHODS CAN BE USED JOINTLY - *some of the holes can be loaded with ANFO and some with stick powder without destroying the effectiveness of the blast.*

Drift or Tunnel Blasting

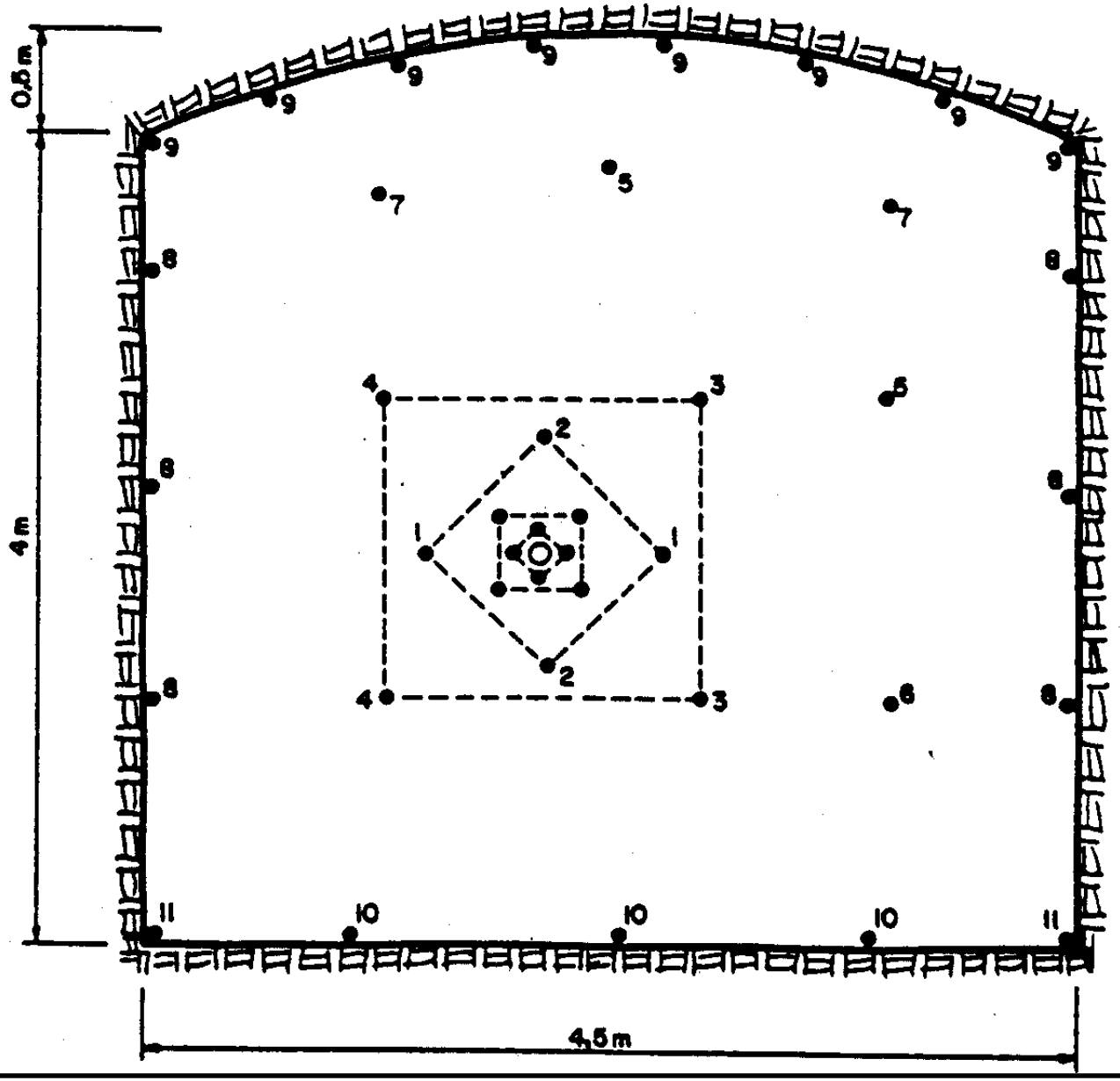
Divided Drift or Tunnel face into Design Sections



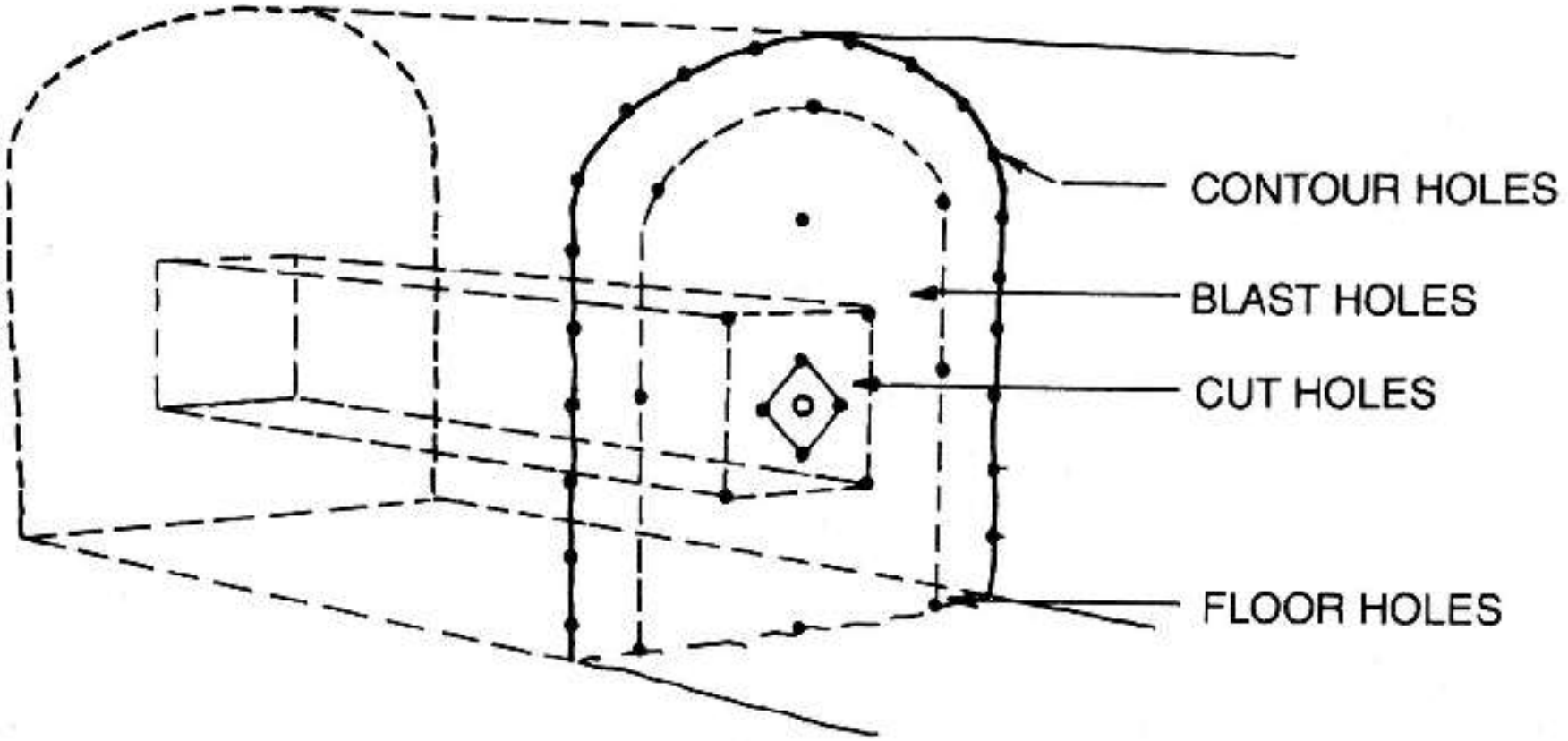
Blast Pattern Design

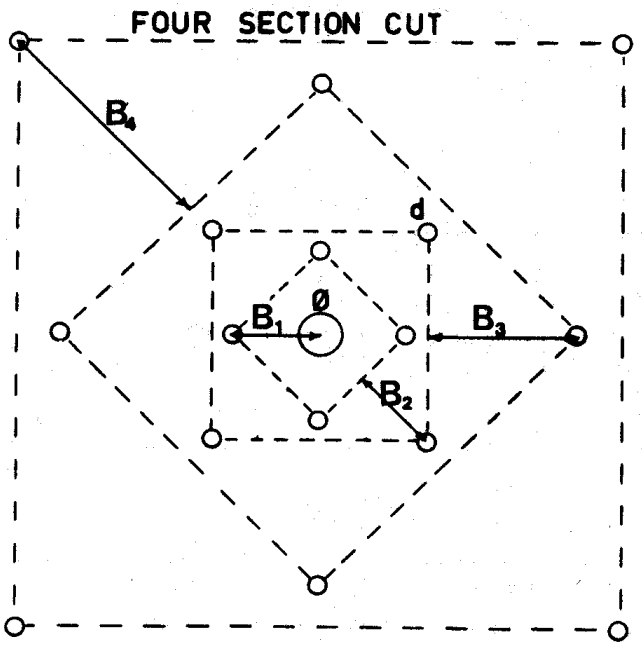
Four section cut.

Large diameter center hole

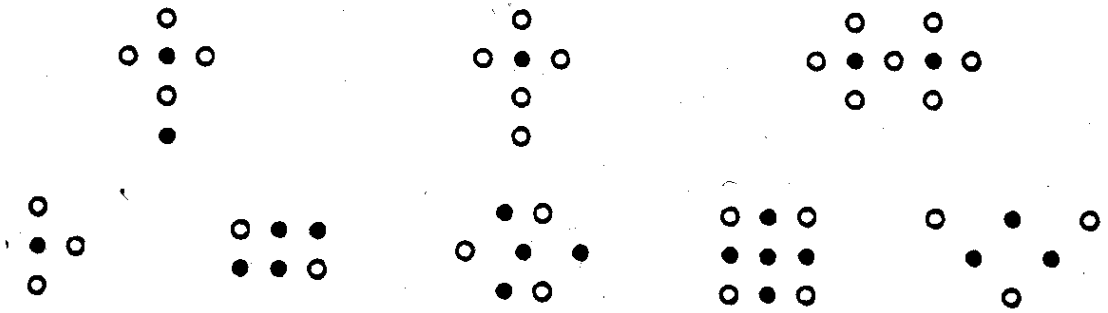


Blast Pattern Design

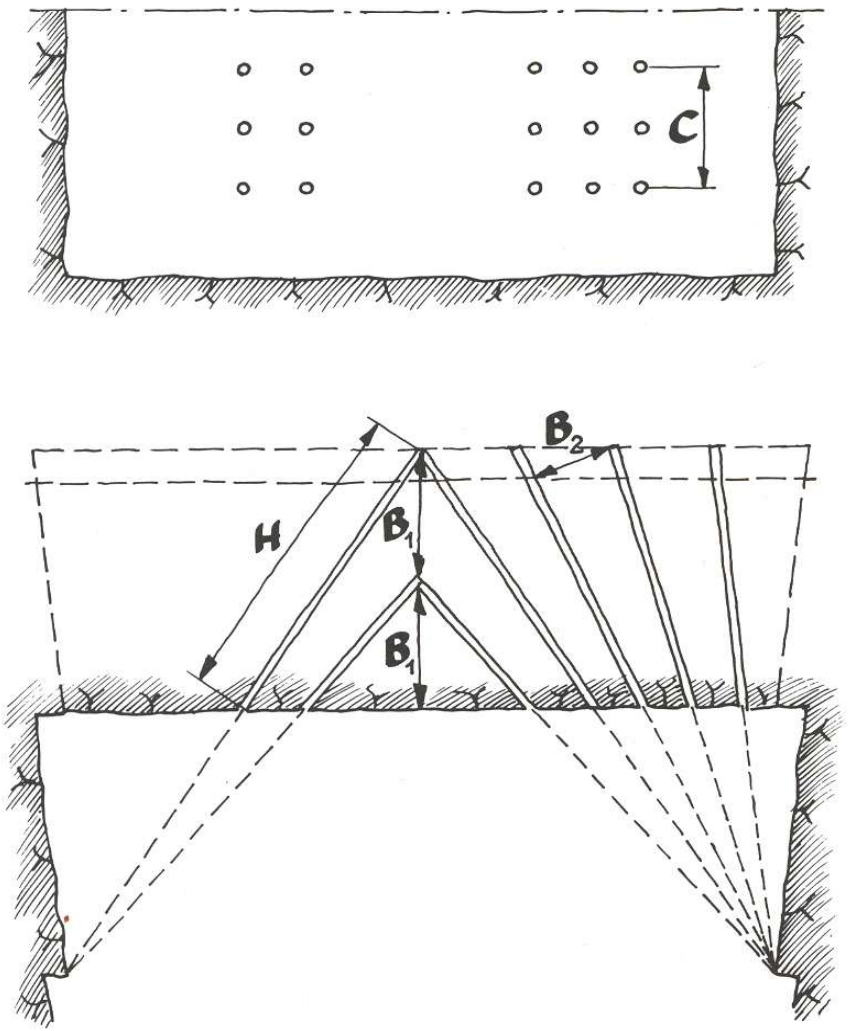




5-hole Burn-Cut

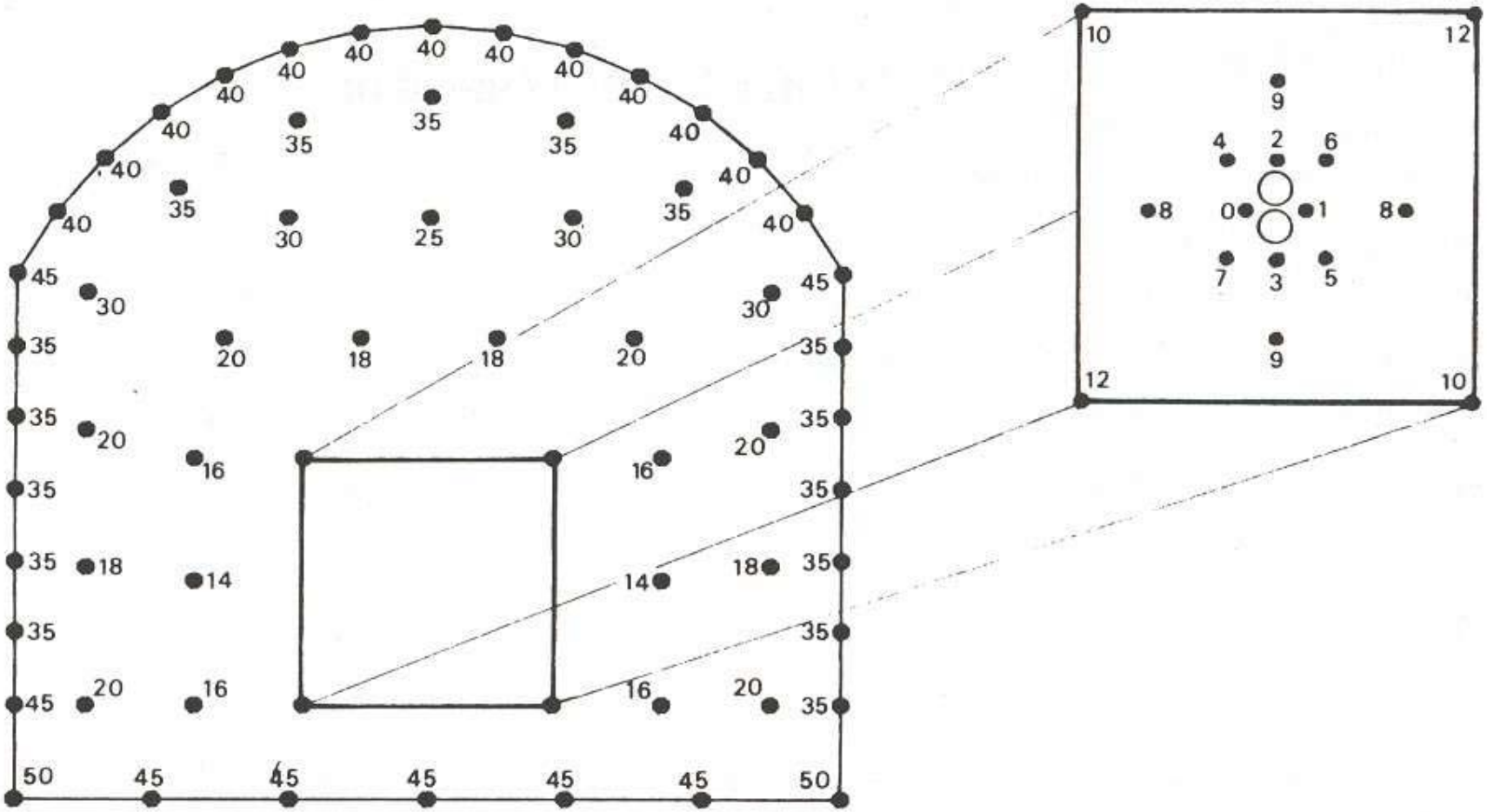


Various Burn-Cuts

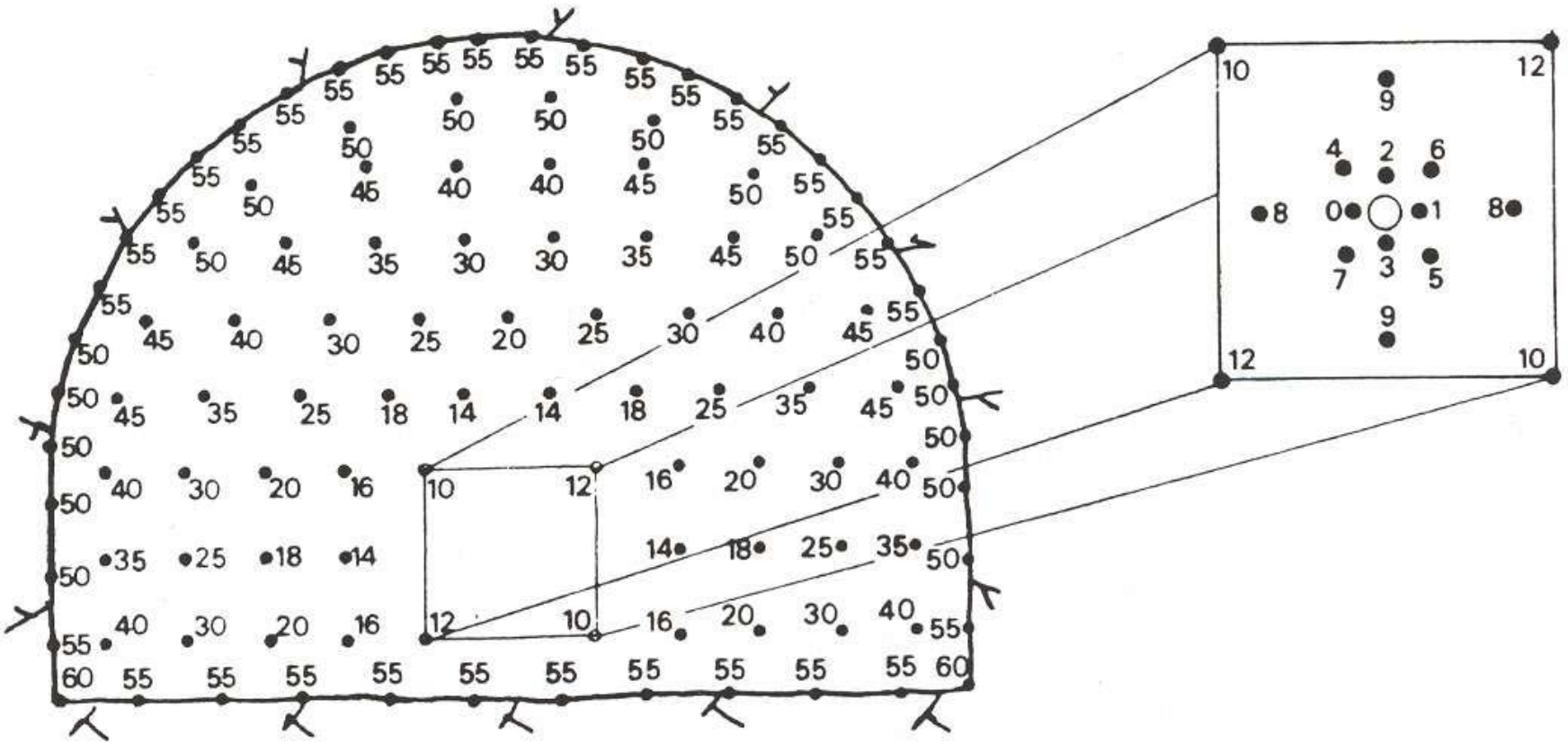


V-Cut

Firing Sequence



Firing sequence for a large tunnel round



Smooth wall Blasting

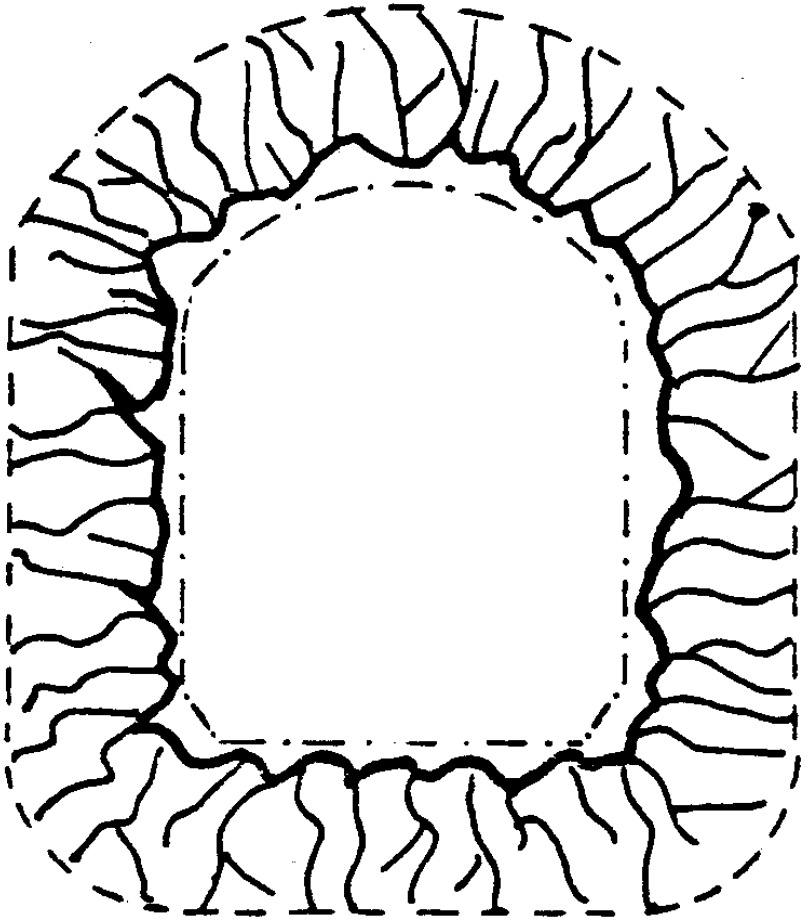


Fig. 8.5 Crack zone from blasting with conventional explosives.

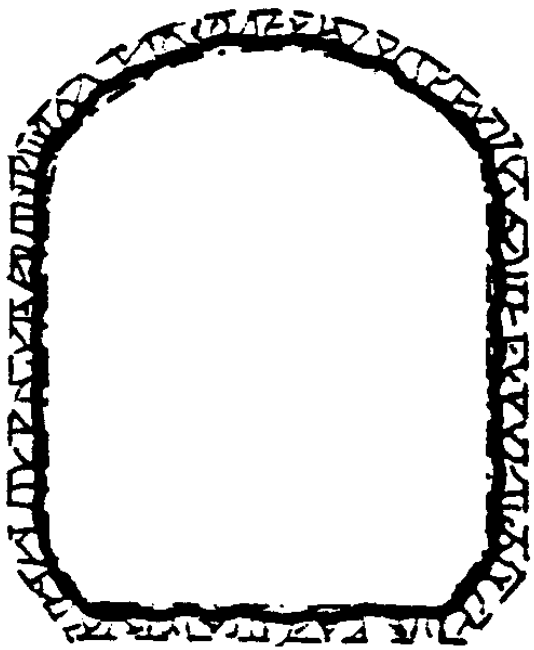


Fig. 8.6 Crack zone from smooth blasting with Gurit 17×500 mm.

Applied Explosives Technology For Construction and Mining, Stig Olofsson, 1997

Ground Support for Drifts and Tunnels

Objective

- to mobilize and enhance the inherent strength of the rock mass so that it becomes self supporting.

Materials used in tunnel support and reinforcement

•Rock Bolting

•Shotcrete

•Steel rib or arch

•Rock Bolt + Wire mesh

•Rock Bolt + Shotcrete + Wire mesh

•Steel arch + Shotcrete

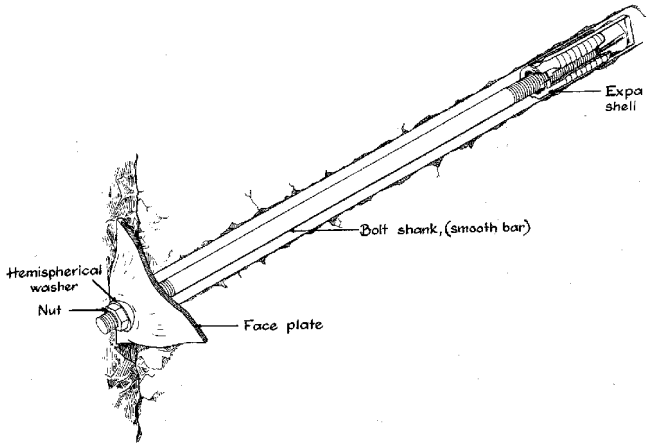
Typical Rockbolt Systems

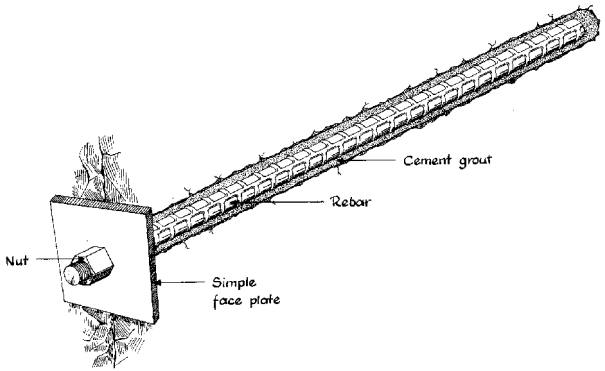
The following groups of bolts are considered based on their anchoring technique:

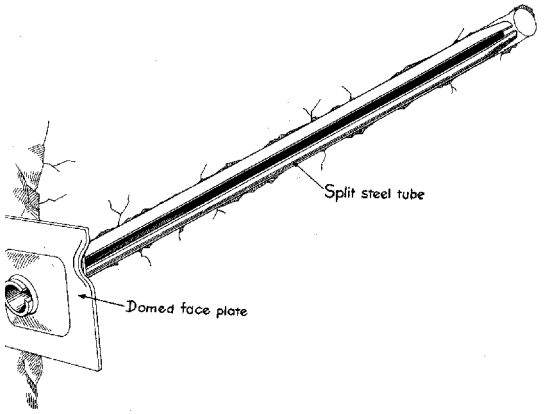
-mechanically anchored rockbolts

-grouted rock- and cablebolts

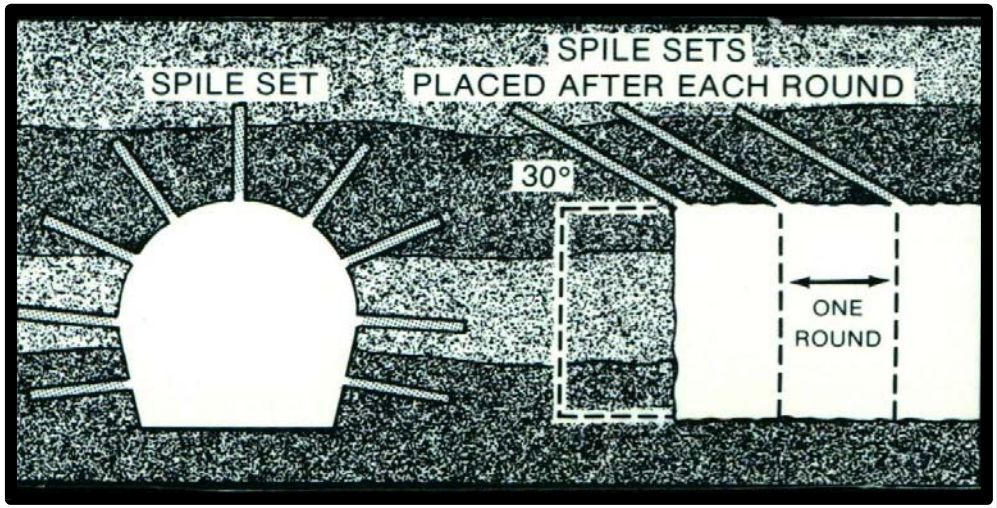
-friction anchored rockbolts.

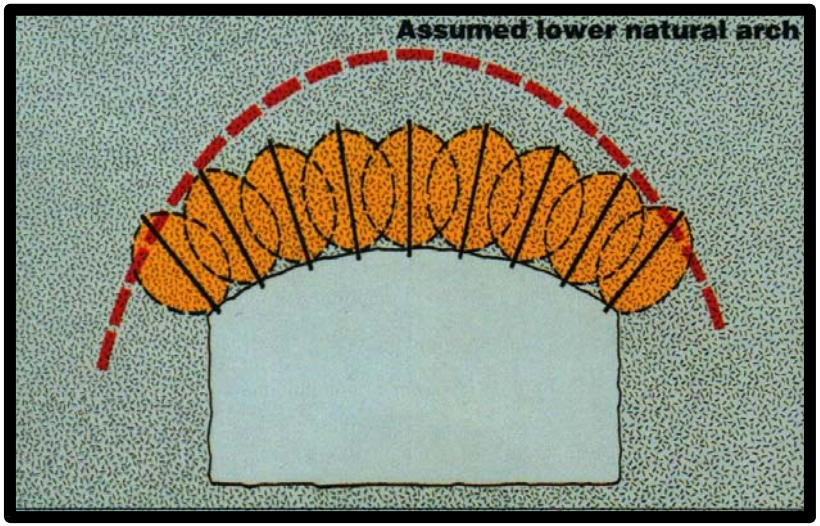




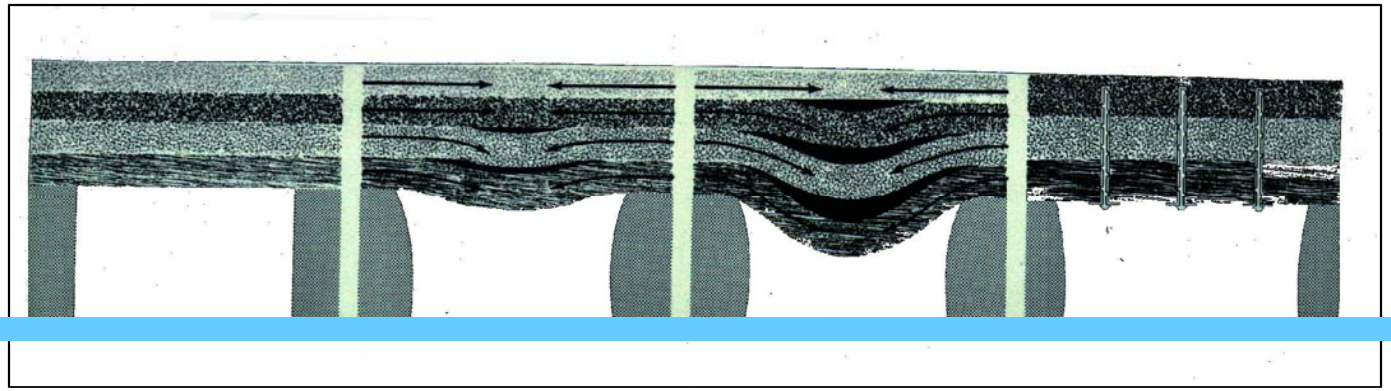


Principles of Rock Bolts

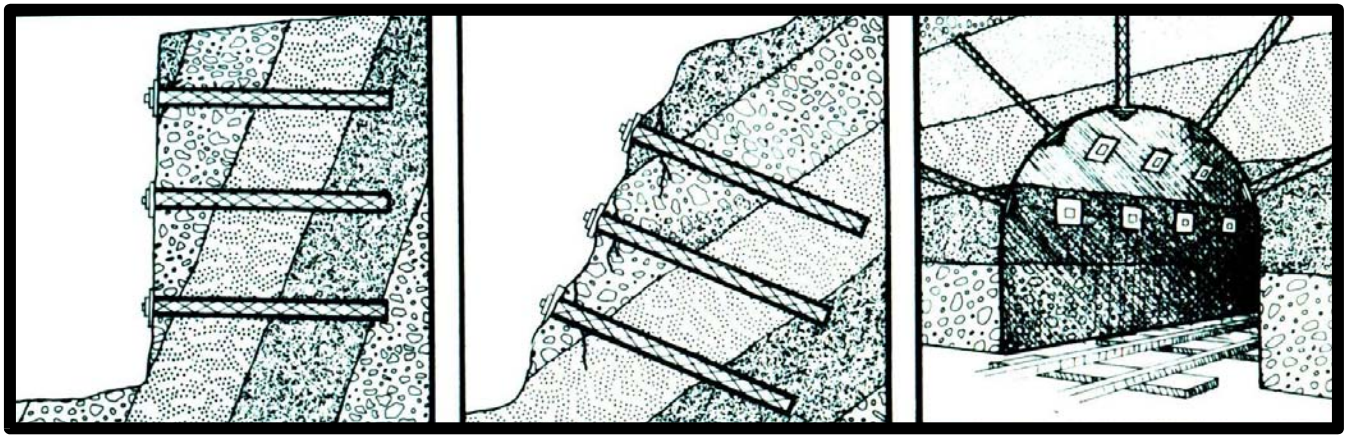




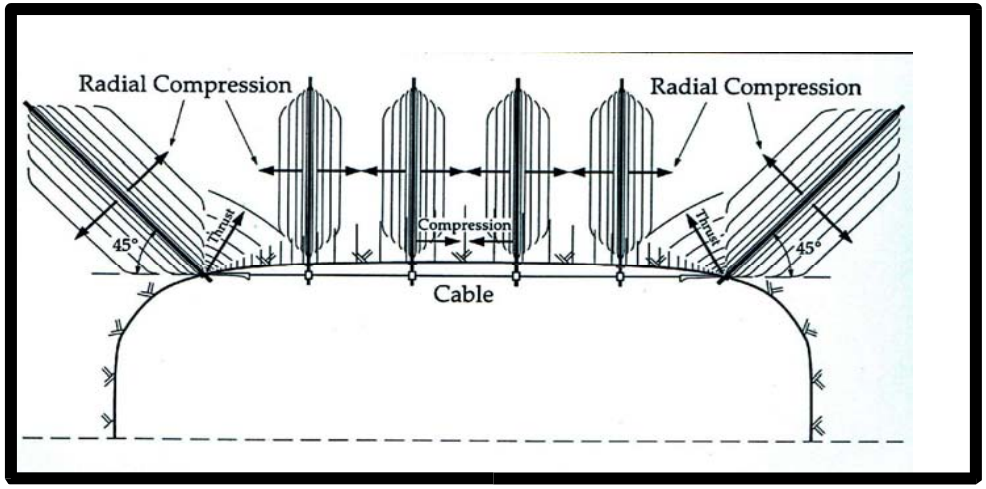
Rock bolts cause compression to the sides of the holes. Compression strengthens the rock.



Rock bolts in a bedded roof cause the layers to act like beams. Tension at the center of the entry is reduced.



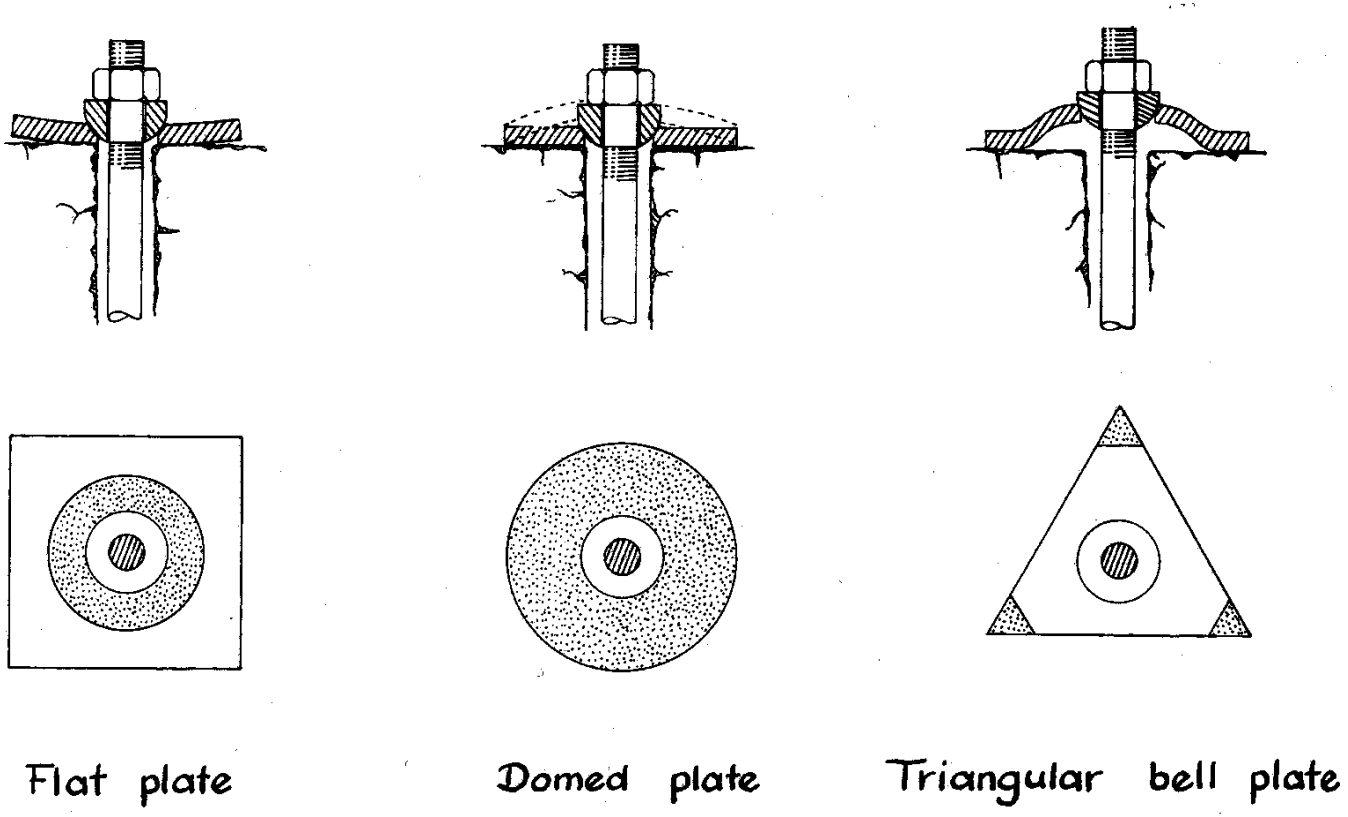
Rock bolts are used for both surface and underground applications.



Rock bolts can be used with other devices to enhance ground support.

Face Plates

A face plate is designed to distribute the load at the bolt head uniformly into the surrounding rock.

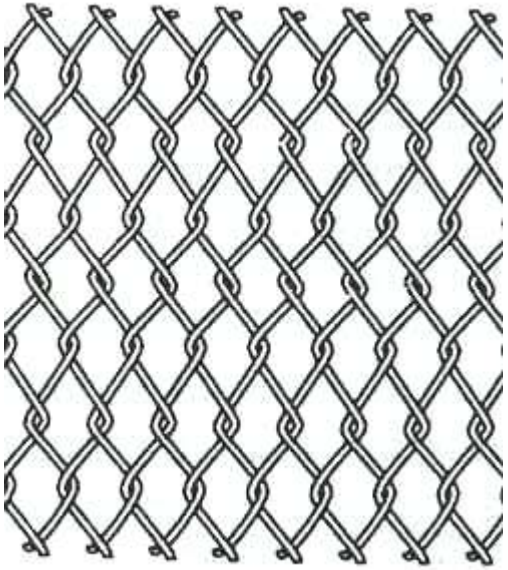


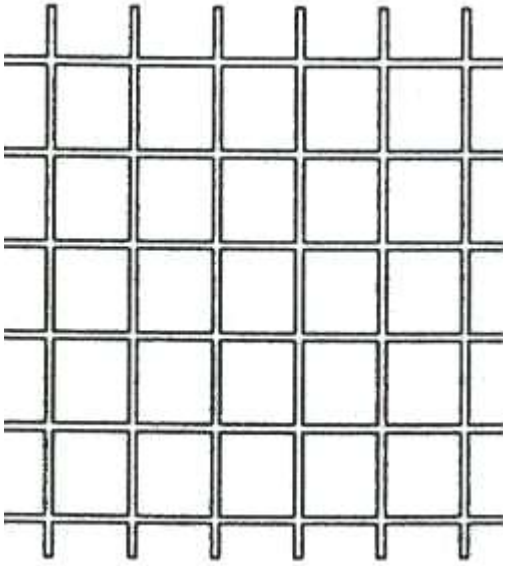
Wire Mesh

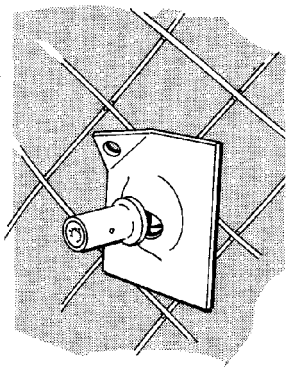
Two wire mesh types are commonly used in combination with rockbolts:

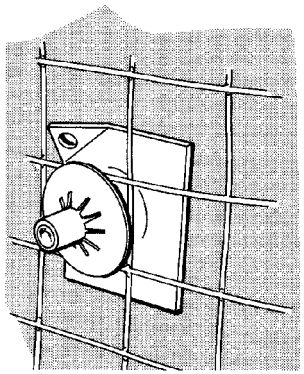
chainlink mesh - weldmesh.

The mesh should be attached to the rock at intervals of between 1 and 1.5 metres. With a spacing of 1.5 -2.0 meters between support points the mesh can carry approximately 2.5 tons per m^2 of broken rock.









The JAMA DBU 800 underground drill/bolt machine.

Shotcrete

Shotcrete is the generic name for cement, sand, and fine grain aggregate concentrates which are pneumatically and compacted dynamically under high velocity.

The main purpose of shotcrete is to help the rock mass maintain it’s integrity.

A two to three inch layer is applied to the rock surface.

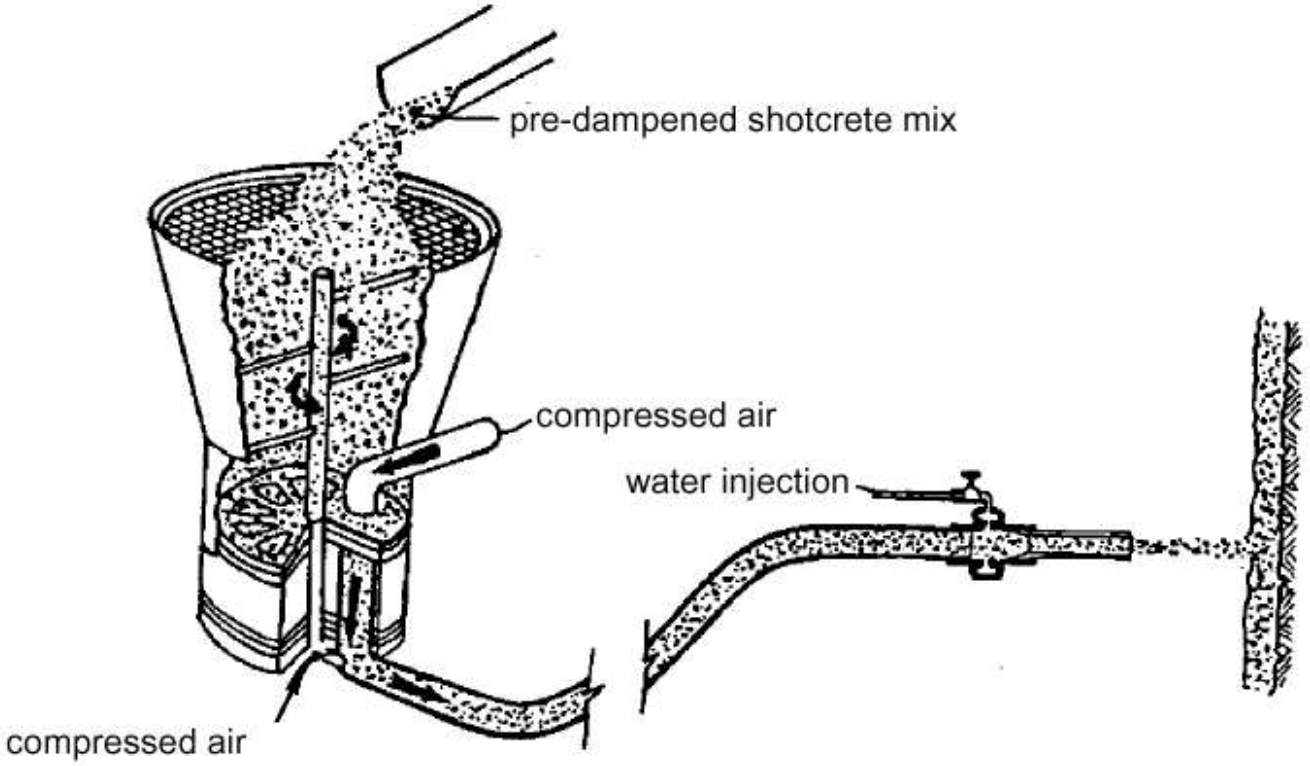
Accelerators are usually added at the nozzle.

Steel fibers are also sometimes added to improve tensile strength. The most common type used today in underground mining is wet mix shotcrete.

Dry Mix Shotcrete

The dry shotcrete components are fed into a hopper with continuous agitation.

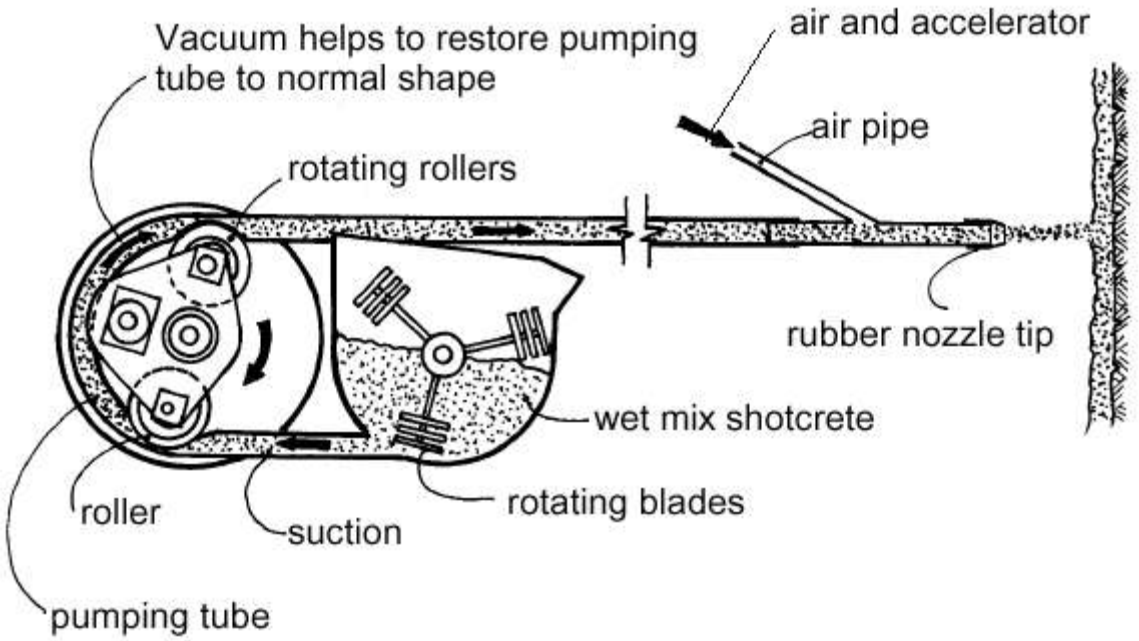
Compressed air is introduced through a rotating barrel or feed bowl to convey the materials in a continuous stream through the delivery hose. Water is added to the mix at the nozzle.



Wet Mix Shotcrete

The wet shotcrete components and the water are mixed (usually in a truck mounted mixer) before delivery into a positive displacement pumping unit,…

…which then delivers the mix hydraulically to the nozzle where air is added to project the material onto the rock surface.



Shotcrete robots

Shotcrete robot applying shotcrete in a tunnel opening

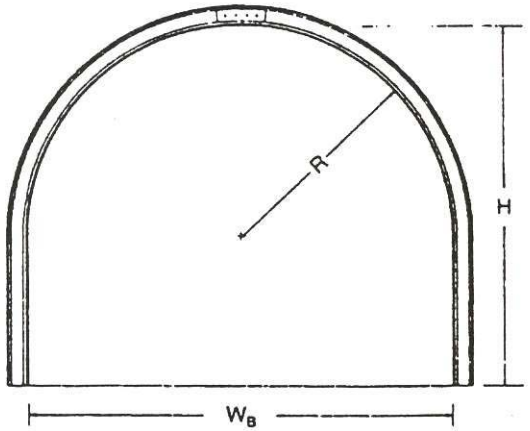
Mesh Reinforced Shotcrete

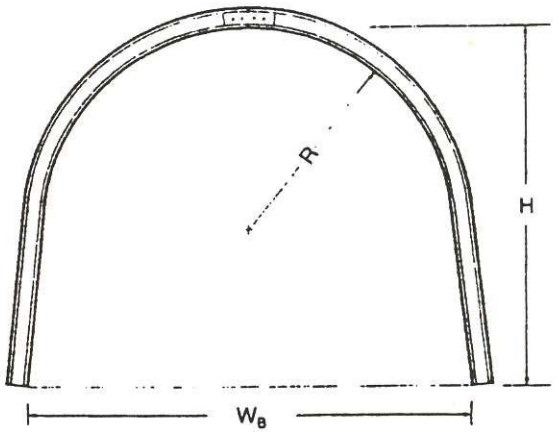
Chain link mesh not recommended because shotcrete can not penetrate

Welded wire mesh, firmly attached to the rock surface, provides excellent reinforcement for shotcrete.

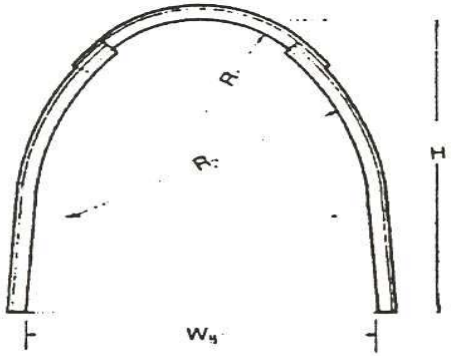
Steel Set Support

Rigid

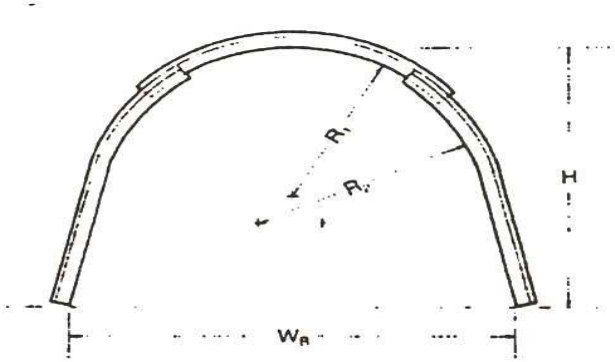




Yielding



For high vertical loads



For soft floor and side squeeze

Timber Support Systems