

LECTURE NOTES ON MINE SURFACE MINING TECHNOLOGY



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Explosive

2nd
Semester

Definition:-

Explosive is a solid, liquid or mixture of substances which change temperature themselves into large volume of gases at high temperature and pressure when flame, heat or sudden shock (detonation) is applied to it.

Composition of an explosive mixture.

1. Combustible material - wood meal, sulphur, charcoal etc
2. Oxidising agents - NaNO_3 , KNO_3 , NH_4NO_3
3. Stabilisers - Mg and Ca carbonates
4. Antisetting agent - Gels to prevent caking of salts
5. Sensitising agent - Metallic powders i.e., aluminium powder. may be used as a sensitizer.

* Properties of explosive

1. Strength :- ✓

This is a measure of amount of energy realised by an explosive during blasting. So, it is the ability of explosive to do useful work.

✓ 2. Velocity of Detonation (VOD)

It is the rate at which the detonation wave passes through a column of explosive
eg → Petn - 7500 m/s Maximum (booster).

More VOD in an explosive means more intimate contact between the oxidiser and the sensitisier. So more strength of explosive.

3. Density

The density is important when selecting explosive for a particular use.

For mining or tunneling in a high ground we need high density explosive whereas to found lumpy coal low density explosive is used.

4. Water Resistance

Explosive differs widely in resistance to water and moisture penetration. The nitrate compound explosive are less effective in watery condition whereas nitro compound explosives like slurry and gelatinous explosive are suitable for wet conditions.

5. Sensitivity

An explosive is required to be insensitive to normal handling, shock and friction but must be remained sufficiently sensitive when detonated.

6. Fume Characteristics

Explosives which are to be used when ventilation is restricted must produce a minimum harmful

gases. Slurry explosives and ammonium nitrate explosives are generally preferred in ventilation restricted area.

7. Legal permission

Only permitted explosives are used in underground mines.

For opencast mines permission is also needed from respective authority for storage and use of explosive.

Depending upon the strength and sensitivity of explosives, they can be grouped into :-

1 → Low explosives or low density explosive

2 → High explosives or high density explosive.

* Low explosive

High explosive

- ① A low explosive is fired by ignition or ignited by shock of violent a flame. Low explosive is very low. High explosive is very high.
- ② The effect of explosive is very low. Low explosive is very low. High explosive is very high.
- ③ When a low explosive is heated the process of oxidation of the constituent substances is propagated by itself hence the rapid combustion from particle to particle. Low explosive does not proceed from particle to particle. High explosive is instantaneous.
- ④ It has heaving effect. Low explosive has scattering effect.
- ⑤ eg → Gun powder. Low explosive eg → nitroglycerine, T.N.T. High explosive NH_4NO_3 , special gelatin and slurry explosive.

Gyr powder

It is made up of following constituents by propagation of weight.

Charcoal - 15%, Sulphur - 10%, KNO_3 - 75%.

None of the constituents is explosive by itself. It has a heating effect. Safety fuse used in mines is made up of gun powder.

Nitro glycerin

It is an oily fluid with specific gravity 1.6 and freezing point at 13°C . It is insoluble in water and is very sensitive to the explosion by giving sufficient shock. The nitro glycerin is more sensitive to shock. When it freezes, so, in the preparation of strong explosives or gelatinous explosive nitro glycerin is used in caking condition.

It have scattering effect.

Here to make nitro glycerine in freezing point an agent called nitro glycol is used to make it more powerful.

Low freezing explosive are designated by a prefix "Polar".

eg - polar Viking, polar special gelatin.

Ammonium nitrate

It is a white hygroscopic salt soluble in water and is very safe to handle.

When it is detonated it gives powerful explosion.

Ammonium nitrate as an explosive can be mixed with diesel oil, NA or T.N.T.

Ammonium nitrate doesnot occurs in nature but it can be prepared in laboratory by reacting ammonium with nitric acid. prill ammonium nitrate can be utilised as fertilisers.

TNT (Tri Nitro Toluene)

It is a chemical formed in reaction between benzene and nitric acid which is highly explosive in nature.

TNT is a cop-sensitive explosive.

Collodion Cotton

A reaction between cellulose compound and nitric acid gives result into a collodion cotton which is a high explosive.

It is used in gelatinous form.

Booster

For effective blasting effective detonation is required some delay and ANFO explosives needs high detonation for it's blasting. So a booster with a trade mark "Paxos" is used to initiate blasting. Booster is a mixture of RDX and T.N.T.

As booster is water resistance and have a VOD around 7000 m/s. So it produce high detonation velocity for effective blasting of explosive. A trade mark "Perfolite" is also used for initiation of explosive via a booster. The explosive which are detonated by booster is called non cap sensitive explosive.

ANFO

Ammonium nitrate mixed with diesel oil is used as explosive in several coal and metal mines. Most oxygen balanced ANFO can be prepared by using 94% of ammonium nitrate with 6% of diesel oil. In mining section the percentage of diesel oil is increased to 8 to 10% as it have poor resistance in watery condition.

In 100 kg of ammonium nitrate 7 litres of diesel oil is required in dry season and the quantity of diesel oil is increased to 9 litres during wet condition.

It have specific gravity 0.8 to 1.

It have 1000-3500 m/s.

It is a cop sensitive explosive but in some special cases booster can be used.

* Slurry explosives

Slurry explosives are gelly like consistency of mixture oxidiser and fuel oxidiser with excess linking starch can be make it gelly like starch can be added during it's preparation.

So the common ingredients are:-

- 1 - Oxidiser - Na , K , Ca nitrate
- 2 - Crosslinking agent - K , Sodium dichromate, calcium or boron compounds

3- Cellulose agent - starch.

4- Accelerator (Fuel) - T.N.T, Perin, Urea, Paraffin.

It has a specific gravity more than 1. It is available in the form of cartridge with plastic wrapper.

It is sap-sensitive explosive with high water resistance properties, so it is highly used in open caste mines.

When slurry explosive is manufactured in plant it's stored as plant mixed slurry. When the constituent of slurry explosive is transported.

through a slurry pump truck and pour to the hole directly in the site is termed as site mixed slurry. In S.M.S system one pump truck can charge nearly 25,000 kg of explosive in a shift.

Slurry explosive produce less fumes and is sensitive to general handling so can be used effectively in mines. In P.M.S. the lifetime of explosive is 1 year whereas it is more effective in between 4 months. It has VOD of 3300 m/s.

Emulsion explosive:

An emulsion is an intimate mixture of two liquids that do not dissolve in each other. The unique feature of an emulsion explosive is that both oxidiser and sensitiser are in liquid form.

The unique purpose of explosive is to minimise the size of nitrate solution to make tight compaction ~~sweet~~ ^{with} fuel oil which is used as sensitiser.

Ammonium nitrate solution can combine with diesel oil and blended to form emulsion explosive. It have a VOD of 5000 to 6000 m/s. so more effective blasting is done where both oxidizer and sensitizer in liquid form.

Permitted Explosive

Dt - 22.07.2018

All explosives create heat and flame when fired. To avoid explosion of gas of coal dust in an underground coal mine. It is essential that the flame and heat produced by an explosion should be incapable of igniting gas and coal dust. For this reason explosive used in underground coal mines are approved by CMRS and DAMS after certain tests.

A permitted explosive is one which has been subjected to stringent test by CMRS and found

to be incapable of igniting fine material (Mn)
or coal dust when used up to a specific
weight.

The permitted explosive cartridge is wrapped
with a plastic material with the letter "P"
on it.

The safety of permitted explosive depend
upon :-

1. Low temperature

2. duration of flame product

The flame should last for 1/1000th second
and for low temperature rating agent like
Sodium chloride, potassium chloride and calcium
chloride are mixed in the permitted explosive.

Besides all these other constituent of
permitted explosive is Na based or NH_4NO_3 based
permitted explosive is grouped into following
categories :-

P1 - Unsheathed explosive such as Ajax C_2 ,
Viking C_1 and slurry explosive like
hydrogex.

P2 - Sheathed explosive

P3 - Equivalent sheathed explosive eg - misox C_1
pernadynex.

P4 - Explosive approved for special purpose
for delay firing, firing in ripping and
known as ultra safe explosive.

P5 - Sort of blasting explosive
eg - sort X, pernadynex etc.

P2 and P4 explosive are not manufactured in
India also not used in mines. The edge
of a sheathed explosive is coated with sodium
bicarbonate when blasting occurs NaHCO_3
decomposes to carbon dioxide and water. So it

sensitive the plane produced at it's source!

In equivalent weighted explosive an inert material like the mixture of ammonium chloride and sodium nitrate is directly mixed throughout the explosive composition which helps in reducing the temperature when explosives blasted.

In Indian mines condition P5, explosive is used in gase II and gase III.

Permittive explosive are cap sensitive explosive.

Heavy ANFO (CHANFO)

The latest development to use emulsion slurry mixed with different proportion of ANFO to give better resistance and higher density explosive named as Heavy ANFO.

The emulsion to ANFO ratio can be formed with: 20:80 or 50:50 depending on the sensitivity of watery condition and effective blasting.

The mixture has bulk density 1.1 to 1.25 g/cc

Guideline for use of explosive

- 1 Only permitted explosives approved by Dams should be used in underground coal mines. Such explosives are always cap sensitive.
- 2 Non permitted explosives can be used in underground metalliferous mines as well as surface mines.
- 3 In watery places gelatinous and semi-gelatinous explosives should be used but Nitro based powder explosive are not recommended at water bodies.

- 4 Slurty explosives are water resistance and they can be used in watery holes but ammonium nitrate based slurty explosive with specific gravity one or less than 1 should not be used in watery holes.
- 5 Only explosive with high VOD over 2500 m/s is used for blasting in hard ground.

EXPLOSIVE ASSESSORIES

① Detonators

A plain detonator is a aluminium tube of 6 mm dia 37 to 50 mm long and filled with ASA composition and PETN in 1/3rd part of the tube.

* The ASA composition consists of a mixture lead oxidized (A), lead sulphate (S) and aluminium powder (A). The ASA composition

is used as prime charge as it starts initiation system at the first stage in the process of blasting.

* PETN (Pentaerythritol tria nitrate) used as the base charge in a detonator as it is more powerful explosive with VOD more than 7000 m/s.

* The plain detonator or ordinary detonator are of instantaneous type and need a safety fuse for it's fire. Plain detonator is available in two forms No. 6 detonator and No. 8 detonator. No. 6 detonator is suitable for mining work whereas No. 8 detonator is more powerful but not generally used in mines.

Ordinary electric detonator

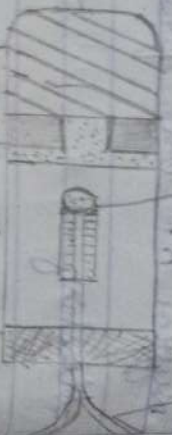
Ordinary electric detonator

one of two types, low tension

detonator and high tension

detonator.

Labels: PETN, ASA, Steptone, (Cheschoy) (Primer), (Primer charge)



Low tension detonators are generally used in mines whereas the high tension detonator is more powerful but not for the mining purpose.

The ordinary electric detonators are of instantaneous type that is without any delay element.

A copper of aluminium tube house PETN as base charge and ASA composition as prime charge and occupies 1/3rd part of the tube length. They are not fired by ignition of safety fuse. But by passing electric current through a fuse head. The current required

for the ignition of fuel head is 0.5 ampere and can be blasted with a minimum voltage of 3.5 volt :

The resistance of two tension detonators with a 45 m short firing cable is around 7Ω .

The continuity of the circuit of low tension detonator is tested by galvanometer.

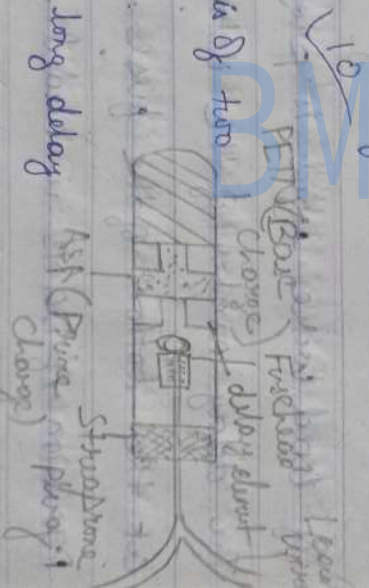
* Delay Detonator

Delay detonator is of two

types :-

- ① half second or long delay
- ② millisecond or short delay.

The delay detonator has a delay element provided between the fuse head and pressure charge. The delay element consists of copper or brass sleeve filled with antimony and



Potassium permanganate increase of long delay detonator. In case of short delay detonator lead silicon or lead can be used as delay element. The free head consists of packing materials, lead monomeric sesquioxide (LMNR), Potassium chlorate, charcoal etc. The delay detonator can be distinguished by the colour of lead wire which is projected outwards.

The delay number of the detonator is stamped at the bottom of the fuse.

Provision of DGMs is needed before the use of delay detonator. During storage delay and non-delay detonators cannot be kept in same box. box, and lead, metal laboratory

Advantages of delay detonator

- ① Reduce consumption of explosive as blasting is more efficient. Due to availability of free phase for each row.
- ② Fragmentation is better.
- ③ The millisecond delay detonator produce less ground vibration.

④ More fire is sound as fire of shot is within a fraction of second.

Safety free

It consists of a core of fine grained gun powder wrapped with layers of plastic tape and water proof coating. The burning speed is usually 100 to 120 cm/min. When one end of the fuse is ignited. It leaves the place at a uniform rate to ignite the detonator. Generally

The length of safety fuse used in ordinary detonator is 1.2 m. It is manufactured in different brands to use in different conditions. Double full brand $\longrightarrow$ dry condition. Blue dump brand $\longrightarrow$ damp condition. Orange colour plastic sheaf $\longrightarrow$ wet condition and

surged condition.

D-Cord / Detonating Cord / Cordex

The detonating fuse looks like a plastic cord having external diameter 5 mm and weight about 20 gms per metre. It has a VOD of 7000 m/s. It is instantaneous in its action. Detonating cord is filled with PETN within its core. It is also available in the shade name Cordex To initiate the explosive by ordinary

detonator it provides the grade of
Propagant which will explode the dynamite
as well as the explosive cartridge.

* NONEL

The NONEL system of detonation is developed
by Nobel A.B. of Sweden. NONEL means non-electric detonator. It
is a flexible plastic tube having 3mm
external diameter and 1.5mm internal
diameter. The tubes of available in free cut
length, one end of which is fitted with a
non-electric delay detonator whereas the
other end is sealed. During blasting the
end having detonator is lower down into
the blast hole whereas the seal end is
projected outwards and initiated by a

detector itself. The advantage of novel is to provide steady current and protect the blasting from radio transmission, flow friction etc. So it is a measure against misuse. It also produce less ground vibration and eliminates electrical circuit testing.

RAYDET

It is a non-electric initiation system which combines the advantages of electric detector and detonating cord. It consists of plastic tube, contains a small quantity of explosive material on it's inner surface. A high strength No. 8 instantaneous or delay detonator is crimped to one end of the ray tube. When RAYDET is initiated by

detonator the stray tube having explosive carries the state of propagation. So that continuity of VOD is maintained.

The stray tube is available 3 to 45 metre which can eliminate the need of discard within a shot hole.

It has in the form of 0 delay to NO 15 delay stray tube formation to give the advantage of delay detonator.

Detonating Relay

In open cast working detonating delay provides a non-electric delay firing system. This method avoids electric connection which is required to blast a delay detonator.

A detonating relay is a flexible tube

where one end have a delay detonator and the other end have a non-electric detonator and connected via a detonating fuse inside the tube.

Both the end of the tube is open to receive the detonating fuse, which is needed for initiation. Here, the delay time varies between 15 to 45 milli second and can be used in a series connection blasting.

Exploder

It is a portable apparatus which provides the current necessary for firing electric detonator is called an exploder.

It is safe, quicker and more convenient method for electric shot firing.

It is of following types :-

① Dynamo exploder or magnets exploder.

② Battery condensed exploder.

③ Condenser dynamo exploder.

Magneto exploder / Dynamo exploder

It consists of a permanent steel magnet between the poles of which an armature revolves by rack and pinion movement. The voltage generated depends on the speed of the armature which creates magnetic flux and emf is generated.

A low tension exploder gives a voltage about 15 volt and a high tension exploder gives 125 volt.

The exploder used in underground coal mines is of intrinsically safe apparatus.

Battery condensed exploder.

The current in battery condensed exploder is provided from a battery of 4 or more dry cell connected in series. Each battery gives an e.m.f. voltage of 1.5 volt. It can be operated by a detachable key. The company which produce the battery condensed exploder has a trade name Rhino exploder. By this exploder three number of shots can be fired at a time. When using the exploder the two wires of shot firing cable are connected to the terminal on the exploder. Then after the key is inserted and rotated clockwise to provide current to the electric detonator. A Neon lamp

glows brightly when current is provided

Condenser Dynamo exploder

It is the combination of above two technology to provide current for shot firing. Here a battery is charged through the current produced by rotation of armature within a magnetic field.

This is manufactured by Masandira and co company and it is suitable for coal mines having less inflammable gases.

Blasting of Solids (BOS)

In development of gallery coal can be blasted with or without giving or undercuts by using P5 explosive is called as blasting of solid. The following regulation should be obeyed during BOS. That is, regulation number 173 which explains about blast of the solid.

Reg-175 which guide the use of delay detonators.

Reg-168 which describes higher of shot more than 6- round in coal mines.

The pattern of shot holes drilled for solid of blasting are:-

- 1- Wedge-cut.
- 2- Fan-cut.

generally 1.5 to 2.5 ton coal can be extracted by using 1kg of explosive which is also known as powder factor. While using P5 et explosive delay detonation are using which have delay time 150 ms in case of degree I and degree II gassy whereas the gassy III the delay time should not exceed 100 ms.

Advantages of BOS

- 1- It can eliminate the use of coal cutting machine.
- 2- Save of capital can be made by reducing the equipment of coal cutting machine (cutter and cables etc).
- 3- It produce less fumes which helps in ventilation system.

4- Deep drilling is done by Jack and Hammer and with one drill and two helpers to 70 holes can be drilled in a shift of 8 hrs.

Misfire

When entire column of explosive within a shot hole fails to blast is termed as misfire. The different causes of misfire are

- 1- defective firing exploder.
- 2- Low quality of explosive.
- 3- connection error of cable or decoder.
- 4- defective detonator.
- 5- If stemming length is short as compared to the length of shot hole.

Precaution measures of mine :

- 1- The shot firing cable should be checked before blasting simultaneously connections at lead point of detonator and connection at exploder is checked to verify the continuity of electric circuit.
- 2- The exploder should be examined in every three months by a competent person.
- 3- Only good quality of explosive and detonate should be used and stored in magazine.
- 4- It is better to have two numbers of shot firing cable so that leakage of current or short circuit can be avoided in electrical blasting.

Dealing with mine hole

1- If shots are fired with safety fuse no person should enter the side of blasting for 30 minutes after firing.

2- If the electric detonators are used to blast then the time is reduced to

5 minutes after discharging from explosives

3- A red flag is hoisted at the place of mine by the shot fire or blaster.

4- After careful search the shot fire may take necessary steps to blast. The shot hole again by connecting the cables properly.

5- The relief hole is loaded with explosive and stemmed well and with proper connection. The relief hole is blasted

6- If mine exists after disconnecting the cable a relief hole should be made near the mine holes so that the minimum distance of 30 cm should be maintained.

7- The blasted materials with like detonators (if any) should be disposed separately thorough a tub or dumper marked in red colour and destroyed at distance place from the mine sight.

* Secondary blasting

When in primary blasting large boulders are formed then secondary blasting should be done.

It is of three types :-

1. Pop shoting
2. plaster / mud / mud capping
3. Snake blasting

1. Pop shooting

In pop shooting upto 2m hole is done with the help of Jack hammer in boulders.

A small quantity of explosive cartridge is placed in shot holes with proper connection and allowed to stemmed. By connecting each heading wires of electrical blasting is done to ground well fragmented are or mined.

Mud shooting

In this case the boulder surface is cleaned up to free it from dust then small quantity of explosive is placed over the boulder boulders. with proper connection the explosive is covered by clay and allowed to dry out. with the help of detonators the

barrelers are allowed to blast for well
fractured ore.

Snake blasting

In snake blasting line cartridges are
placed beneath the barrelers and with the
help of detonators it is blasted to form
well fractured rock.

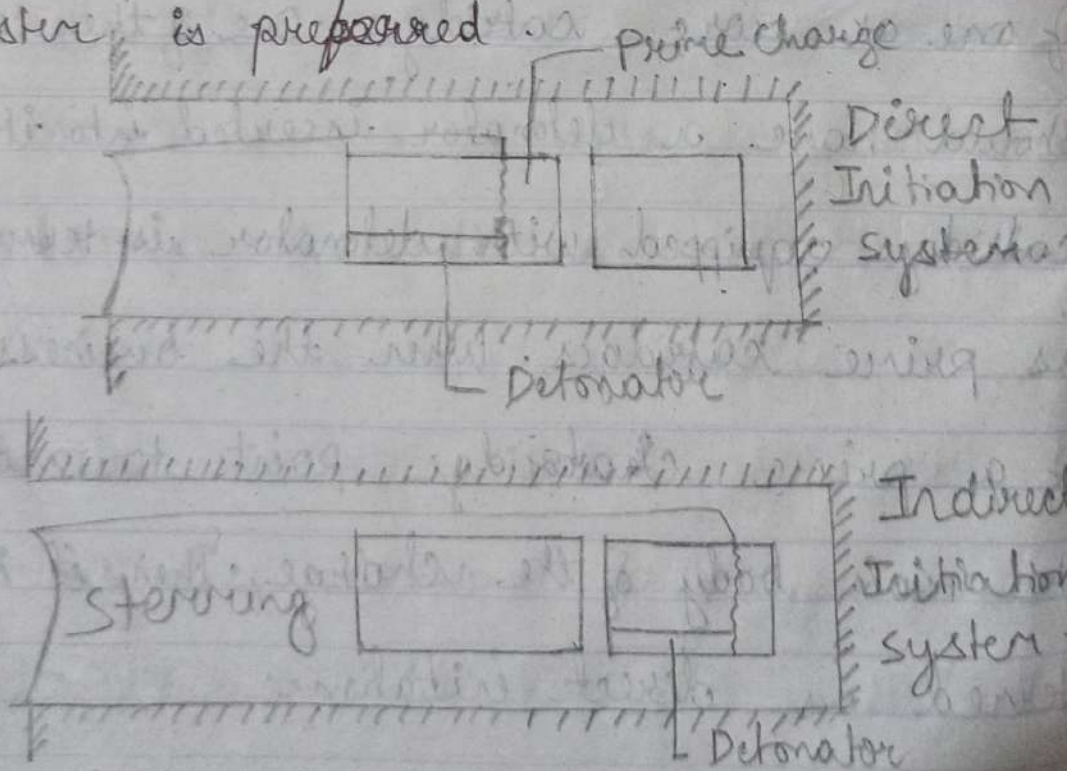
Charging a shot hole

The charge of blasting in a hole may consist
of one or more cartridges. One of the cartridges
should have a detonator inserted into it. Shot
cartridges equipped with detonator is termed
as prime cartridges. When the business end
of a prime cartridge points towards
the main body of the charge. Then it is
termed as direct initiation.

when the detonator is at the back of the charge points towards the front of the hole is termed as inverse initiation system.

In development of galleries in coal mining where we make hole in the wall of coal direct initiation system is generally preferred.

whereas in O/C mines indirect initiation system is preferred.



After the charge is placed in the hole, the shot hole is stemmed with stemming materials, keeping the end of leading wires of detonator lead out of the hole. The stemming material consists of sand and clay in a ratio of 3:1. The stemming material is tamped lightly near the explosive charges and tamped hard near the mouth of the hole.

Complete procedure for a shot hole

1. ~~The~~ Test the shot hole. If a crack is found the hole shouldn't be charged.
- 2- Test the gas eruption from the hole.
- 3- Mark the direction of shot hole on the roof side in underground mines.
4. Charge the hole with explosive.

- 5- Stem the hole first lightly and then
hardly upto it's mouth.
- 6- Spray stone dust or water within
18m of area.
- 7- Warn the workers to clear of the
place and post the helpers to a
suitable place 27m away from
the blasting side.
- 8- Lay out the shot fire cable.
- 9- Test the presence of gas within 18m
again.
- 10- Couple the firing cable to detonator
wires.
- 11- Take shelter.
- 12- Couple shot firing cable to the end
of the exploder.

- 13- Give warning signal for blasting.
- 14- Fire the shot holes with the help of exploder by providing current.
- 15- Allow the fumes and gases to clear.
- 16- Return to the blast site and examine the roof, sides, misfire holes if any and shout "ALL CLEAR" for the workers to return to their work place if the place is safe.

Different types of drilling pattern

1. Cone cut
2. Wedge cut
3. Drag cut
4. Fan cut
5. Burr cut
6. Coronant cut
7. Ring drilling.

Cut holes

In drilling pattern the central hole which is drilled for the purpose of providing free face to easers and trimmers is termed as cut hole.

Easers

Around the cut holes few layers of drill hole are made which gives effective blasting and termed as easers.

Depending upon the ground hardness the easers are loaded and may be kept empty to provide more effective blasting.

Trimmers

Trimmers are the hole which are drilled surrounding the easers which give final shape to a tunnel or drill.

Cone cut / Pyramid cut

Cone cut or pyramid cut is suitable for hard rock where the thickness of the ore body is more and uniform. The ore body is drilled in a circular cut hole is drilled which is vertical and its purpose is to provide free face for effective blasting. Drilling is done from the top and bottom of the ore body to the face to meet at a single point at the back of the cut hole. So termed as cone cut or pyramid cut.

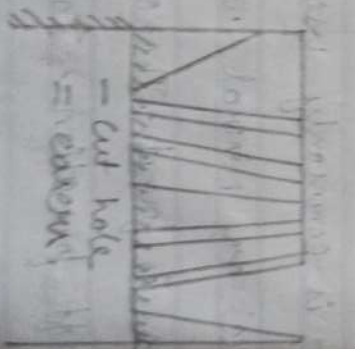
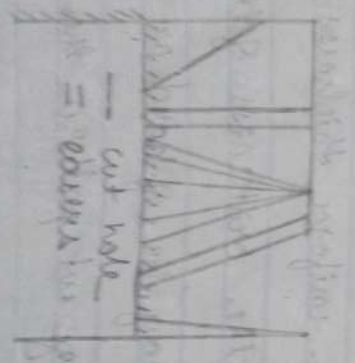
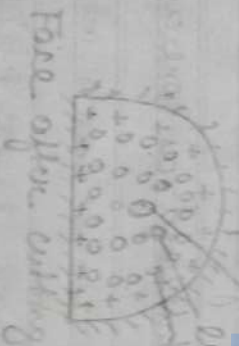
Wedge cut

It is commonly used for uniform thickness ore or mineral where the brittleness of the ore is found. The ore may be of hard or soft formation. In wedge cut pattern the

easers and pyramids are drilled in turn
 sides of cut hole where the pair of holes
 meet at a point on the back side of the
 cut hole. When all holes of easers are
 drilled it seems all pair of holes meet at
 a plain looking like wedge cut. So it
 is termed as wedge cut.

Pyramid or cone cut

Wedge cut



Drag cut.

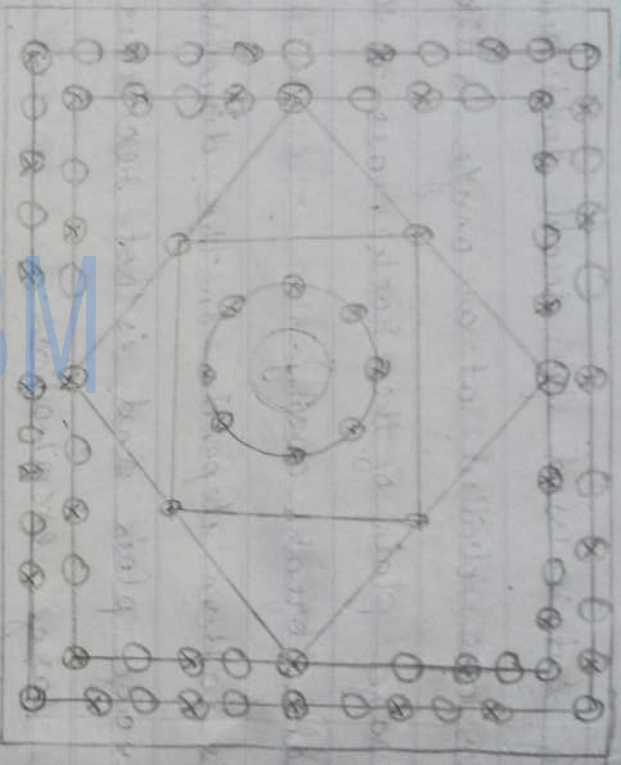
Drag cut is used for small drifts where holes are drilled at an angle to the cleavage plane of the rock mass so that strata breaks easily.

This pattern depends on the direction of cleavage plane and is not recommended for large excavations.

Fan cut

This pattern is favourable for laminated strata and mostly soft rock formation. Here the easers and trimmers are drilled around the cut hole like fan blade. The easers and trimmers are vertical holes and independent of each other.

Burr Cut



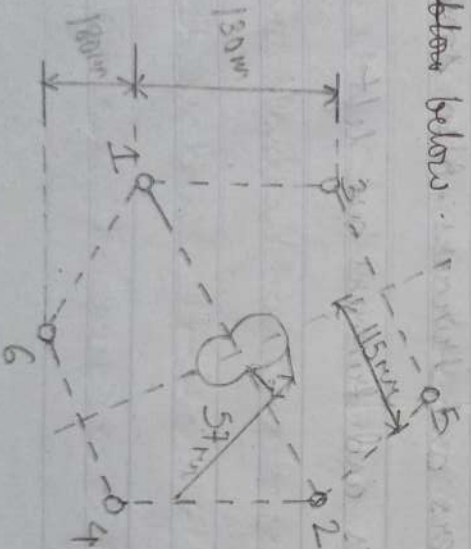
Burr cut is effective in hard brittle and homogeneous ground which breaks evenly but cannot be used in plastic grounds. Here the corners and corners are drilled in such a systematic way that explosive charges bore blasting have no neighbour blasting holes around it. The neighbour holes are kept empty for provision of free face i.e.,

alternate holes can be loaded with explosive for effective fragmentation of stock mass. The drilled hole are nearly vertical to the face it has following advantages, optimisation of blasting can be achieved by using little quantity of explosive as the blast is directed towards the direction of holes drill required less supervision as some of the holes are not blasted. At most time holes broken and holes is practised where the central holes is not charged and having large diameters, than the easers and trimmers. Also some holes of easers and trimmers are left unchanged.

Coronant Cut

The coronant cut is a new type of parallel hole cut where the central cut hole have larger diameter and can be drilled by two holes overlapping each other. According to it the easers and punches are drilled at a pre-planned distance or pre-measured distance from the central hole. This method is generally used for greater advance of about or time in less time. A typical

coronant cut pattern is given in the figure below.



Ring drilling

Generally in underground metalliferous mines ring drilling patterns are adopted for more production in less time in a thick ore body deposits in this system the drillers standing at a position in the gallery called haulage roadway drill different length of hole at different patterns around the same plane. These holes are loaded with explosive and blasted by remote sensation.

The haulage road plan is shown in the figure. In this system, the drillers stand at a haulage road, drill holes at different depths in the ore body. The holes are drilled at different angles to the ore body. The holes are drilled at different depths in the ore body. The holes are drilled at different depths in the ore body.

Blasting Pattern

The various types of blasting pattern are:-

1. Deck charging
2. Chamber blasting
3. Muffle blasting
4. Cushion blasting
5. Simultaneous blasting.
6. Presplitting.

Deck charging

This type of blasting pattern is generally used when alternate hard rock and soft rock formation are there in a drill hole.

In this method the explosive are placed at hard rock layers spacing by air bags at soft rock formation. The total quantity of explosive needed for a shot hole is divided

in quantity and placed in the length of shot hole. Generally $2/3$ rd of explosive are placed at the bottom of the hole and $1/3$ rd of explosive is used in other layer of hard rock formation. But if the length of the hole is shortened by stemming materials.

Chamber blasting - In chamber blasting is generally practised in hard ground where the length of the hole is less.

In this method the bottom of the hole is widened by inclined drill bits to maximize the quantity of explosive at the bottom providing sufficient stemming length. It prevents misfire on blown out of shots.

Muffle blasting ✓

Muffle blasting is generally practised when the

mine is near about a public road through a populated area. This method is practised to prevent the formation of flying rocks. In this method the drill holes are covered up stop of iron rod placed in series across narrow to form mesh. If blasting occurs then the fly rock are restricted to the blasting area only.

Cushion Blasting

Here, the stemming materials is replaced by air bags throughout the length of the hole to give cushioning effect in soft rock formation. Towards the mouth of the hole some stemming material may be used to prevent blow out of shot.

Simultaneous Blasting

When all the holes loaded for blasting is blasted by ordinary detonator is called simultaneous blasting. Simultaneous blasting is generally practised in open cast mines when the holes are connected in series.

Pre splitting

Nowadays pre-splitting type of blasting is generally preferred as well fragmented one can be found by providing delay time.

between number of shots. For this purpose delay detonators are used - It has several advantages

1. Less consumption of explosive
2. Less ground vibration.
3. Eliminates secondary blasting than that of simultaneous blasting.

MAGAZINE

Definition:-

A building where explosives and detonators are stored is called a magazine. A magazine construction must be approved by inspector of explosives.

The magazine should be constructed in a site which must be at a specified distance from public roads and residential quarters.

Under the explosive rule the following magazine can be stored together in the same magazine.

1. Gun powder.
2. Nitrate mixture.
3. Nitro compound.
4. Chlorate mixture.
5. Safety fuse.
6. Detonating fuse, etc.

Procedure for establishing a magazine.

An application in the form of 'C' and 'D' should be made to the regional controller of explosive as well as chief controller of explosive. If the chief controller of explosive will issue a copy of licence in form 'E' then the ~~object~~ district magistrate will issue a No objection certificate for the construction of magazine.

Types of Magazine

Depending upon the capacity of magazine it is of two types :-

1. Portable Magazine.
2. Large Magazine.

Portable Magazine

A portable magazine requires licence from chief controller of explosive and should be located at safe distance from,

1. From all buildings, temples, office, schools, factories apart from 95m.
2. From all roads, rivers, playgrounds and market apart from 48m.
3. From overhead high tension electric line about 91m apart.

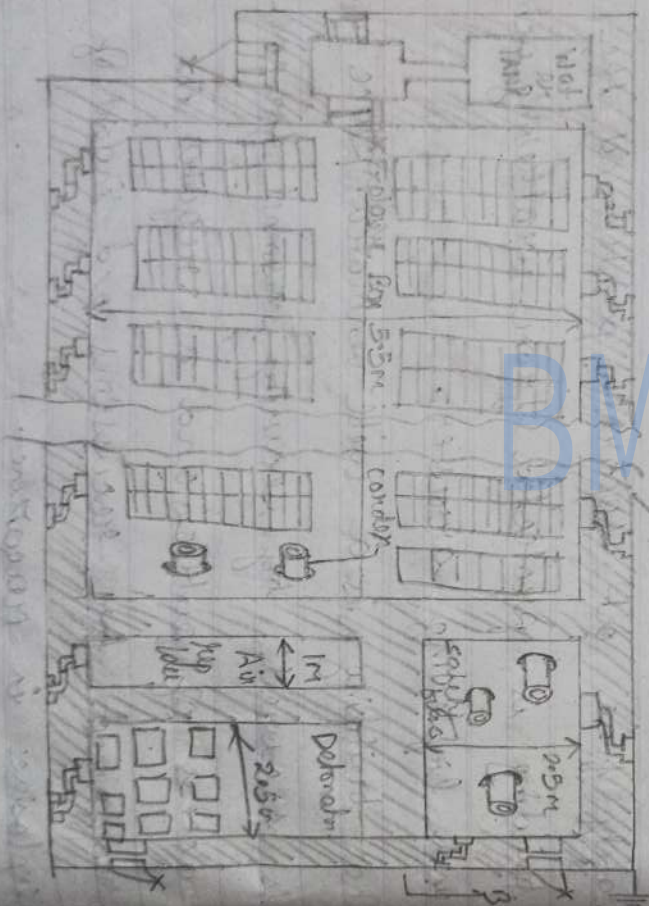
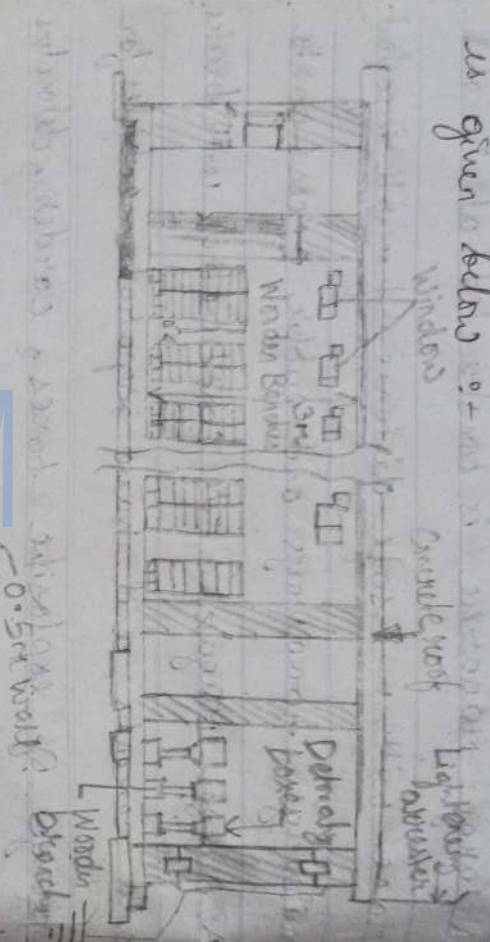
The portable magazine have a capacity of 100 kg to 500 kg of explosive and can be constructed (5m x 2m) area in a steel cabin like structure. Maximum 100 to 200 detonators can be stored in a portable magazine at any time.

Large Magazines

A large magazine is constructed at remote place with a safe distance from all inhabited buildings, roadways and public access points. A large magazine is constructed with brick and cements and have separate cubicles for storage of explosive boxes, corder, detonators safely free at separate points and the building is protected from weathering action and lightning arrester.

The building is a well ventilated place and is secured by security personnel for non-access of public and a register is maintained for excursions and indent of explosive in magazine.

A typical layout for a large scale magazine is given below :-



Shaft sinking

It is a process of making shafts to access the ore bed or mineral bed which has been proven at greater depth below the earth surface. Shaft may be circular or rectangular in shape but circular shaft are widely used in many countries to access to mineral deposits.

Before shaft sinking the following data are essential and planned:

1. Configuration of shaft size.
2. Selection of water control system.
3. Estimation of sinking cost and time.
4. Design of shaft and it's permanent lining.

The equipment needed for shaft sinking are:-

(a) steam engine, diesel engine for supply of power or availability of electric power.

(b) steel headgear structure, headgear pulley

winding engine and winding drum.

(c) Air compressor for the operation of a drill machine and other activities.

(d) Fan of $300 \text{ m}^3/\text{min}$ capacity for the purpose of ventilation.

(e) Generators for lighting.

(f) Shaft rendering arrangement.

(g) Folding doors to cover the shaft mouth and also one erected around the shaft sinking.

(h) Signalling arrangement.

(i) Tram line for the disposal of debris.

(j) Workshop for the maintenance of machine.

(k) Lamp room, first aid room, magazines stores, office etc.

Different types of shaft sinking methods are:-

- (i) piling method.
- (ii) caisson method.
- (iii) Freezing method.
- (iv) Concretion process.

Piling Method

Piling method is more suitable for loose deposits like sand, mud or alluvium near the surface upto a depth of 20m.

In piling method interlocking steel piles of 6m to 10m length are hammered and allowed to dip into the surface. The connected piles are water tight and it's length can be extended by welding other sections of piles. The piles are set up to form a ring and hammered down in rotation.

As the piles descend into the loose ground the excavated materials within that enclosure are cleared up from that ring when the excavation reaches in strong ground or rock bed then permanent lining is constructed and the shaft sinking procedure is then normally practised as per our requirement.

Caisson Method.

Caisson method can be divided in three classes.

(a) sinking down process / open caisson method

This method consists of a cylindrical well of brick wall of 0.3 m to 0.4 m in thickness over an AHS using having steel cutting shoes.

The shaft is excavated and the drum sinks down gradually by its own weight. Further brick work is added on the top as the drum sinks down. Concrete sinking drum can also be used if the ground is soft in nature.

b) Forced drop shaft method:

This is commonly adopted where the strata consists of alternate tough and loose ground and also the drop shaft refuses to sink further due to hard ground. In this case sinking is carried out with the help of hydraulic rams which forces down the cast iron drums beyond the hard ground. This method is used upto a depth of 60m from the ground surface.

(c) Pneumatic caisson method.

This method is adopted when there is a danger of ground filling of the shaft or a influx of water to the sinked shaft.

Compressed air is fed into the chamber formed by a partition above the cutting shoe.

The compressed air compresses the air to sink further apart from the water and sand in sunked **to** the shaft. This method

can be used upto a depth of 30m for giving the foundation of bridge or tall buildings.

Freezing method

This method is used when sinking is

proceeding through an unstable strata with heavy influx of water. The water

freezing strata preventing the water flows inside the sinking wall. The freezing method consists of following three processes :-

(a) The first operation consists of drilling holes from the surface.

(b) The second operation is to insert cold brine (solution of salts) through a pipe inside the holes, so that water from the strata is frozen and carrying out the blasting operation.

(c) It consists of surrounding the ice wall by sending hot brine to the hole for elevating the accumulated water through pump.

This method is scarcely used in India.

MINE:

Mine are such place in earth crust where presence of ore or mineral deposit is maintained by geological survey of india.

Mining:

Mining is a process excavating mineral or ore of economic value from the earth crust for the benefit of mankind.

Mineral:

Mineral is a homogeneous and naturally occurring substance having definite physical properties and a composition which can be expressed by a chemical formula.

Access to mineral deposit:

The different approaches to reach the ore or mineral are:-

1. Adit
2. inclined
3. shaft
4. Box cut or approaching haulage roadways.

Adit:

Adit is a horizontal rising roadways into a hilly deposit where one end is open to sky and other end is blunt in the hilly mass.

Incline :

When a mineral bed is at a shallow depth, it can be approached by an inclined and incline is a sloping rope driven from the surface to the deposit through alluvium and rough mass.

→ A locomotive can be operated can be shown less than 1 in 15 and a truck or dumper can operate with a maximum slope of 1 in 14.

→ The normal practice is to have and inclined along the true dip of the deposit. In case of steep base the gradient of inclination may be 1 in 4.

Direct Initiation :

In this explosive charge is placed in a shot hole and the primary cartridge fused last of all and the business end of the detonator towards the end of hole. This position of primer cartridge is called direct initiation.

It prevent ignition of fire clamp, blown out sheet and gives minimum of coal yielding having a free face.

Inverse Initiation :

In this the primer cartridge pushed in hole then explosive charge pushed and the business end of detonator towards the mouth (front) of the hole. This position is called inverse initiation.

Physico-mechanical Property of rock:

Weight:

$$D = \frac{W}{V}$$

$$W = \text{weight of solid}$$
$$V = \text{Volume of solid}$$

Specific gravity:

The specific gravity of any material is the ratio of its own density to the density of water.

Void ratio:

$$e = \frac{V_v}{V_s}$$

$$\frac{V_v}{V_s} = \frac{\text{Volume of void}}{\text{Volume of solid}}$$

Porosity:

$$P = \frac{V_v}{V}$$

Density:

It is defined as mass per unit volume of rock. They are 3 types of density

1. Bulk
2. skeletal
3. dry.

Degree of saturation:

It is the ability of a porous material to allow a liquid to pass through it's pore.

Permeability:

It is the ability of a porous material to allow a liquid to pass through it's pores.

Stress:

It is defined as load applied on a material per unit area. $\text{Stress} = F/A$

Strain:

It is the ratio of change in length of sample due to applied load to the original length of the sample.

$$\text{Strain} = \frac{\Delta l}{l}, \quad \Delta l = \text{change in length}$$
$$l = \text{original length}$$

Poisson's ratio:

It is the ratio of lateral strain to longitudinal strain or linear strain.

PMS (Plant Mixed Slurry):

In this the component are ANFO and slurry explosive it may be mixed in plant which is always from the blasting side.

In PMS system, the explosive is loaded into a special tanker of pump truck & the slurry is pumped directly in to the blast hole where volume of blasting is high enough to justify the cost of transporting.

TCL Ltd has designed pump truck which is capable of pumping powerful slurry directly

→ into the blast hole.

SMS (site mixed slurry):

SMS is more safer than PMS & SMS.
Mostly used in 9/2 mines as compare
PMS and it is cheap.

In this component the explosive are covered
and in a liquid form in different containers
- the component from the pump push to
the supply to the blasting site.

C_1 = intermediate
slurry

C_2 = intermediate cross linker

C_3 - Sensitizer



Method of exploratory drilling:

(i) According to the basic action:

(i) Rotary percussion :- used for hard to soft
formation

(ii) Rotary drilling :- soft formation to
hard formation

(iii) Rotary percussion drilling :- hard to
external

b) According to the basic power used :-

- (i) Manual or hand drilling method $\rightarrow$ for soft formation
- (ii) Mechanical or power drilling $\rightarrow$ for hard formation

c) Test drilling :

Drilling constitute the final stage in ground water exploration. The following types of drill are apply for test ~~can~~ drill, construction of well :

- (I), hand boring drill
- (ii) Percussive drilling
- (iii) Rotary drilling
- (iv) Reverse rotary drill