GOVERNMENT POLYTECHNIC JAJPUR

Lecture Note on

Surface Mining Technology

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Surface Mining Technology

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The determination of the most economic final pit layout to ascertain the mineable ore reserve which depends upon the following

1) the geometric outline of the orebody
2) the distribution of ore with in the orebody
3) the topography
4) Maximum possible slope angle etc.

Dip

Dip is the angle of inclination with respect to horizontal plane.

Strike

It is the line of intersection of horizontal Plane & Bedding plane.

Factor

1. Geology or Geography (dip, Strike)
2. Legal Status of land & mining rights
3. Historical, political, Sociological factors
4. Mining condition
5. Ore treatment requirements.
6. Economic analysis
7. Transportation system, Power supply, labour availability, manufacturing & repairs.
8. Quality / amount of reserves
9. Ground water studies
10. The depth & character of overline strata or overburden
11. Economic analysis for a surface mine about marketing & caste production, capital investment.

Dt - 31/07/2019

Quarriable Limit

The cost of removing overburden and its thickness goes up as the mining operation extend to the deepside of the property or deposition.

At the deepside of the property there is a point at which the cust of mining of mineral is the same as that up selling prise of the mineral and the quarry work in no profit and no loss at this point.

Therefore quarriable limit is horizontal distance from outcropping point to the point at which mineral can be extracted just recovering the mining cost.

The quarriable limits deperds up on the Stripping ratio and the inclination of core body.

Various parameters of a bench

Width

It is the horizontal distance bet^n the crest point and toe of the bench.

Height

It is the vertical distance between the foot and crest of the bench.

Face

It is the surface area along the height of the bench for it full length.

Toe / foot

The lower side of a face of a bench along its length is known as toe line and the various point on this line is known as toe point of that bench.

Crest

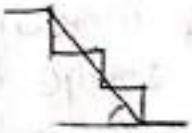
The upper side of a face of a bench ~~along~~ this is known as crest line and the various point on this line is known as crest point of that bench.

bench Slope angle

This is the angle which the face of Particular bench makes with horizontal is known as bench slope angle.

Pit/overall Slope angle

This is the angle which an imaginary line makes with horizontal, the lower point of this line being at the foot of the lower most bench and upper point being the crest of the top most bench.



Gestation period

This is the time interval bet^n mining start to the production start.

Stripping ratio

It can be defined as the ratio of volume of overburden remove to weight of recoverable mineral reserve.

Economy of the mining depends on that of the overburden because as the depth increases cust of extraction of overburden increases.

$$\text{Stripping ratio} = \frac{\text{weight of recoverable mineral (ton)}}{\text{volume of overburden } (m^3)}$$

$$\text{unit} = \text{ton}/m^3$$

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Break- even Stripping ratio

The point beyond which the mineral/coal can't be economically extracted out is called Break-even Stripping ratio.

It can also be defined as the ratio of excess cost required to produce per tonne mineral ore coal by undere ground method in comparision to open cast mining method to the Stripping cost pere unit meter of over burden by open cast method.

Advantages & disadvantages of open cast Mining

→ Larege working faces coupled with the possibility use of large and efficient equpment may very large output possible.

→ Size of excavation does not limit the equpment size in open field as in undere ground mines.

→ Largere equipment and batter organization makes the labour productivity (OMS) much highere. (output/Man/shift)

→ The cost of Mining is generally lowere with open field method as compair to the undere greund method.

→ There is greater flexiblity of production with open field mining production can be varied rapidly, stop and started again when desired with greatere.

→ Percentage of extraction is highere and nearly Full extraction can often attained, the mining losses being in significant in regulare deposite.

→ Sporting can be more easily done.
→ Greatere geological investication of the diposite is possible in open field, thus making exploration easiere and estimation of ore reserves more accureate.
→ Large faces in open field lead in batter specific drilling and lowere specific explosive conserption.
→ Support and filling are generally unnecessary in open field except fore land restoration.
→ Safety of work is greater.
→ except in extreim climent or environmental condition of working are fare batter in open field mine than in underc ground mine. The aire is less polluted and the condition of heat & humidity are generally not so oppressive lighting is natural and much better except fore night work. No artificial ventilation is necessary in open field mines.
→ Supervission is more effective.

Disadvantages

→ It is possible to the mine only to relatively shallow depth by open it's method economic Stripping ratio determining the altimate it depth.
→ Large capital outlay is necessary or mordon mechanite open fields.
→ Work Suffer / in extreim climate condition. Night work in open field is less effecience than day work.
→ Snao and rain may disturb transport system
→ A larege volume of weast / overburden has to be remove which not only adds to the mining cost but also inverse the problem of find suitable

dumpping sight.

→ Large area of ground surface area affected by extraovation which can be restore at additional cost but it is rairly possible to completely restore the original ecosystem.

→ Some times intervening waest rock in the mineral deposite makes open field vesses scattered leading to increase cost of mining.

Dt-05/08/2019

Box cut

opening up of open pits is done by an opening cut fore the development of firest worcking bench. The opening cut is called the box cut and slope of suitable gradient ~~and economical point of view fore transport holding space and minimizing the co~~ is necessary.

(Steepest is adviseable both technical and economical point of view fore treansports, holding space and minimizing the cost of excavation fore pits)

Box cut is excavated initially down to the floor level of the firest bench from the surface. Then a level trench fore opening is extended from this opening cut to forem the firest bench.

The opening trench is narcreow keeping due reegards of the turening of the machineries used fore excavation and extends along ore acceress the quarriable limit depending on the type of the deposit.

When the firest bench is sufficiently advanced the box cut is oriented and extended to the next lower keeping due reegards of the sufficient amount of rooms for the approach road to the top (1st) bench and

fore opening trench fore the 2nd bench.

This way a number of working benches are developed and the width of the boxcut should be sufficient enough to diversify the approach road to all the benches.

If numbers of benches are developed from one opening cut, the cut should be started enough away from the pit limit so that bottom bench can be reached at the desired slope of the pit.

This type of opening cut may be very long and may be curved depending upon the shape and extend of the deposit.

fore opening up in hilly deposit a central trench cut is given across the top level for the first bench or from one side in the same contour level forming a length of face which will give the required production rate.

Objective of box cut

The main objective of boxcut are

i) To reach the ore body
ii) To provide a smooth entry to the pit
iii) To provide space for development of working and production benches.

Types and applicablity

Box cut are up two types

i) Internal
ii) External

Internal box cut

When the boxcut is located fully are partially on the mineralised zone, it called an internal boxcut.

This is applicable fore all types of deposit.

The cut follows a direction i.e usually oblique to the both the strike and deep direction.

Generally the direction is so choosen that the haul road ramp forem by this cut and subsequent will not have unnecessary step turning had any position.

External box cut

When the boxcut is totally out side the mineralised zone it is called an external boxcut.

This is applicable only fore shallow and gently deepting bedded deposite.

The cut is generally located at the middl of the rise most side.

Box cut parameters

The main parameter of the boxcut are

i) Maximum level difference
ii) width of the floore
iii) longitudinal inclination of the floore
iv) freont slope angle and side slope angle.

Slope Stability 01-08/08/2019 chapter-3

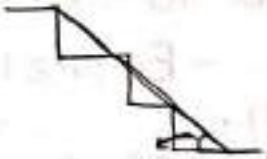
It is the slope of the excavation at which the bench excavated area will extend safety through it life till the mineral body is fully extracted. It is the factor of safety of slope angle.

Pit slope angle is the main factor of slope stability.

Pit slope

It is the inclination of the line joining the top most of all the benches. This occures in normal area of running the mine.

The angle of slope remain flattere (33°)



final pit slope angle

It is the pit slope when the mine boundry is reached. It is steepere as compair to pit slope. It is 45° or may be more, depending up on the competence of the rock.

The slope stability depends upon following factore

i) Geometry of the bench (height, width, no. of benches)
ii) physicomechanical properties of the rock.
iii) Geological disturbance.
iv) local climatic condition and weathering.
v) ground watere pressure.
vi) rate of advance.
vii) flow of water over the benches.
viii) Presence of plane of weakness
ix) Orientation of the bedding (dip & strike of the bed)

Different types of failure

1- Plane failure → failure along a plane.
2- Circular failure → failure along a curve.
3- Wedge failure → failure in the forem of wedge.
4- dopping failure → failure in the forem of toppling.

Prevention of Slope ~~Stedri~~ failure

→ Geometry of the benches should be proper i.e height nevere morce than width
→ For running benches width should be 3 times of the height.
→ For final slope condition width should be equal to the height.
→ Ensure the competency of the rock and ore body.
→ If there are geological distrubance, bench should not be Ilel to any such geological disturbance specially fault.
→ ground water level should be lower down by advance bumping through the poor holes by a Sumerssible forem.
→ The roate of advance should be optimum
→ There should not be any undere cutting.

Dt-10/08/2019 Explosives and Blasting Assessories

Explosive

Explosives is a solid, liquid or mixture of substances which change themselves instantaneously into a large amount of gases in high temp. & Pressure when a flame, heat, swiden shock (detonation) is applied to it.

Detonation

It is the process of giving sufficiently voilent of two explosives to bring about and almost instahteneous rearrangement of the atoms.

Composition of a Explosive Mixture

1. Combustible Matter → Wood meal, fiber, Sulphur, charcoal etc.
2. Oxidising agent → Sodium nitrate ($NaNO_3$), Ammonium nitrate (NH_4NO_3) Potassium nitrate (KNO_3) etc.
3. Stabilization → Mg & Ca carbonate
4. Antisetting agent → to prevent caking of salt
5. Sensitiser → Metallic powder i.e Al, Cu may be use as sensitiser

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Properties of Explosive

1. Strength

This is a measure of the amount of energy release by the explosive during blasting & hence it is ability to do useful work.

2. Velocity of Detonation (VOD)

It is the reate at which the detonation wave passes threough a ~~column~~ column of explosive.

More VOD in explosive means more intimate contact between oxidisere & sensidizore so more strength of explosive.

3. Density

The density is important when selecting an explosive fore a perticular use fore mining. Tunneling in a higher ground we need high density explosive.

Where as to found lumpy coal low density explosive used.

4. Watere reesistance

Explosive differe widely in resistance to watere & moisture penitration.

In nitreate compound explosive is less effective in watery condition.

Where as nitro compound explosives like Slurry gelatinous explosive suitable wet condition

5. Sensitivity

An explosive is required to be insensitive to noremal handling, shock, & friction but must be remain sufficiently sensitive when detonatore is used.

6. Fume characteristics

Explosive which arce to be used when ventilation is to be restricted must produce a minimum harmful gases.

Slurry explosive and Amonium Nitrate based explosive are generally prefered in ventilation restricted area.

1. Legal Permission

Only permitted explosive are use in undere ground mines.

fore open cast mines permission is also needed from respective otherities fore storage & use of explosives.

Dt-18/08/2019

* Depending upon the strength & sensitivity of explosive, Explosives are grouped into

i) Low explosive & Low density explosive
ii) High explosive & High density explosive

LOW EXPLOSIVE

i) A low explosive is fired by ignitation on a flame.

ii) The effect of explosion is very low

iii) When a low explosive is blasted the process of oxidation of the constituent substance is propagated rapid combustion from particle to particle.

iv) It have heaving effect

ex- Gun powdere.

HIGH EXPLOSIVE

i) High explosive is ignated by shock of violate nature like detonatore.

ii) The ~~effect~~ explosive react with high speed.

iii) High explosive always contain an ingradient which is explosive itself hence the process of oxidation does not proceed from particle to particle

iv) It have scattering effect.

ex - Nitroglycerine, TNT special gelatine, Slurry explo.

Classification of explosive

Under the explosives rules, the various explosives & accessories are classified under the heading.

Class-1 → Gun powder

Class-2 → Nitrate Mixture (eg. GN/1, Power flo, Godyne, Pentadyne etc)

Class-3 → Nitro compounds (eg. -Blasting, Gelatine, Special gelatine, OCG, Permitted explosive, PETN

Class-4 → ~~chorate~~ Chloreate Mixture

Class-5 → Aluminate

Class-6 → Ammunition, Safety fuse, detonating fuse, detonatores, delay detonator, ray det

class-7 → Fire works

Class-8 → Liquid Oxygen explosives.

Gun powdere

It is made up of following constituent by Proportion of weight.

Charcoal - 15%

Sulphere - 10%

Potassium Nitrate - 75%

None of the constituents is explosive by it self.

It have heaving affect.

Softy fuse use in mines is made up of gun powder.

Nitro glycereine

It is an oily fluid with specific gravity of 1.6 & freezing point at 13°C.

It is insoluble in watere & very sensitive to the explosion by giving sufficient to shock.

The nitro glycereine is more sensitive to shock in freeze so in the preparation of slurry explosive ore gilatineous explosive nitro glycereine is use in caking condition.

It have scattering effect.

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

Low freezing explosive are designated by a Prefix "polare".

ex- polare viking, polore special gelatine etc.

Ammonium nitrate (NH_4NO_3)

It is a white hygroscopic salt, very soluble in watere & is very safe to handle.

When it is detonated it gives powerful explosion.

Ammonium nitrate as an explosive can be mixed with disel, oil, Nitro glycerine or TNT.

Ammonium nitrate does not occures in nature but it can be prepared by reacting ammonia gas with nitric acid.

Ammonium nitrate can be utilize as ferdilizere.

TNT (Trinitreo Taluhe)

It is a chemical which is forem in reaction bet^n benzene & Nitric acid. which is highly explosive in nature.

TNT is a cap sensitive explosive.

Collodion cotton

A reeaction between cellwase compounds & nitric acid yield a collodion cotton.

Which is high explosive.

It is use in gelatinous forem.

Cap sensitive :-

The explosives which can be blasted with the help of detonators aree said to be cap sensitive.

Ex - TNT

Non- Cap Sensitive

The explosive which can be blasted by keeping it in close contact with a boostere aree said to be non- cap sensitive.

It is also known as "boostere sensitive"

Ex - AN, diesel

Boostere

~~flore~~ effective blasting effective detonator is required some slurery & AN-FO explosive need for it's blasting. so a boostere with a trade mark "Primex" is used to initiate blasting.

Boostere is a mixture of ~~Bot~~ PETN & TNT

As boostere is watere resistance & have a velocity arreound 7000 m/s so it produce high detonation

velocity for effective blasting of explosive.

→ A Treade mark "pentolite" is also use for initiation of explosive as a boostere.

→ The explosive which are detonated by boostere is called non-cap sensitive.

ANFO (AN-fuel oil Explosive)

Amonium nitrate mixed with disel oil is used as explosive in severeal coal & metal mines.

Most oxygen blanced ANFO can be prepared by using 94% of Amonium nitrate & 6% of disel oil.

In rainy season the persent of diesel oil is increases to 80 to 10% as it have poor resistance in watery condition.

In 100kg of Ammonium nitrate 7 lit of diesel oil is required in dry season & the percent of diesel oil increases 9 lit during wet condⁿ.

It have specific gravity 0.8 to 1.

It have VOD 3500 m/s

It is a cap sensitive explosive but in some special cases boostere can be use.

Slurery explosive

These are jelly like consistency mixture of oxidiser & fuel sensitisore with cross linking agent to make it jelly like starch can be added during it's preparation.

So, the common ingradients are

1. Oxidisere - Sodium, Potasium, calcium nitrate

2. Cross linking agent - potassium / sodium dichromate antimony ore boron compound

3. Gelling agents - Starch

4. fuel sensidiser - TNT, PETN, urea, Paraffin

→ It has a specific gravity more than '1' it is available in cartridge with plastic wrapper.

→ It is cap sensitive explosive with high water resistance property so, it is highly use in open cast mines.

→ When slurry explosive manufacture in plant it termed as plant mixed slurry (PMS)

→ When the constituent of slurry explosive transport through truck & poure to the hole directly in the site it termed as site mixed slurry (SMS) In SMS system one pump truck can charge 25 ton of explosive in a site.

→ Slurry explosive produce less fume & insensitive to general handing so can be used effectively in mines.

→ In PMS the life time of explosive is 1 year where as it is more effective in bet^n 4 month

→ It has VOD - 3300 m/s

Emulsion Explosive

An emulsion is an intimate mixture of two liquid that do not dissolve in each other

→ The unique feature is an emulsion explosive is that both the oxidizere & sensidisere ~~in each other~~ are in liquid form. The unique property of explosive is to minimize the size of nitrate solution to made tight compasion with fuel oil which is use as sensidizere.

→ Ammonium nitrate solution can combined with diesel oil & blended to emulsion explosive

→ VOD → 5000 - 6000 m/s

→ Effective blasting is done when both sensitizere & oxidisere in liquid form.

#Heavy ANFO

The Latest development to use emulsion slurrey mixed with different properction of ANFO to give watere resistance & highere density explosive named as heavy ANFO.

→ The emulsion ANFO reatio can be formed with 20:30 ore 50:50 depending on the severity of watere condition & effective blasting.

→ The mixture has bulk density 1.10 to 1.25 gm/c.

Permitted Explosive

→ All explosive create heat & Some flame when fired. To avoid explosion of gas ore coal dust in an undere ground coal mine, it is essential that the heat & flame produced by an explosive should be incapable of igniting the gas ore coal dust.

fore this reason explosives fore use in underground coal mines are approved by the CMRS & DGMS aftere certain tests.

→ A permitted explosive is one which has been subjected to strengent test by the CMRS & found to be incapable of igniting ~~the gas ore coal dust. fore this reason explosives fore use in underground coal mines are approved by the~~ fire damp ore coal dust when used up to a specific gravity.

→ The permitted explosive cartridge of permitted explosive wrapped with plastic bag marked with the lettere 'P'.

→ The safty of permitted explosive depend upon
  i) Low temperature
  ii) Duration of flame produce.

→ The flame should last for 1/1000th sec. & for low temp. cooling agent like NaCl, KCl are mixed in permitted explosive beside at othere constituent of explosive NG based of ammonium nitreate based.

Group

P_1 = Unsheathed explosive, such as Ajax G, Viking G, Slurry explosive like Gadyne.

P_2 = Sheathed Explosive

P_3 = Equivalent Sheathed explosive (Unisaar G)

P_4 = Explosive approved fore special purpose such as fore delay firing, firing in ripping etc. These are not produce in india

P_5 = off-the-solid explosive (fore solid blasting eg:- Soligex, Slurry explosive Pentadyne)

→ P_2 & P_4 are not manufacture in india also not use in mines.

→ The cartridge of a sheathed explosive is coated with sodium bicarbonate when blasting occuree $NaHCO_3$ decompose to H_2O & CO_2 so it restrictly flame Produce at its sources.

→ In Equivalent sheathed explosive an inert material like mixture of ammonium chloride & soda nitrate is directly mixed through out the explosive composition which helps to reducing the temp. when explosive is blasted.

→ In indian mines P_5 explosive is use in Gasy-II, Gasy III mines.

→ Permitted explosive are cap sensitive explosive.

Guidelines for use of explosive

1. Only permitted explosives approved by DGMS should be used in underground coal mines such explosives are always cap sensitive.

2. Non-Permitted explosives can be used in undere ground metalliferous mines and in the quarery mines of coal as well as metals & also for other surface application.

3. In watery places, gelatinous & semi-gelatinous explosive should be used but NG based powdery are not recommended for blasting at watery places.

4. Slurry explosives are water resistance & they can be used in watery holes but AN based slurry explosives with a specific gravity of one or less should not be used in watery holes.

5. Only explosives with a high velocity of detonation over 2500 m/s should be used for blasting in hard rocks.

Explosive Accessories

Detonators

High explosive are initiated by detonators or detonating fuses.

A detonator is a small copper or Aluminium tube containing a small charge of special explosive.

Detonators are of following type

i) Plain Detonators / Ordinary Detonators
ii) Ordinary electric detonators
iii) Delay Detonator

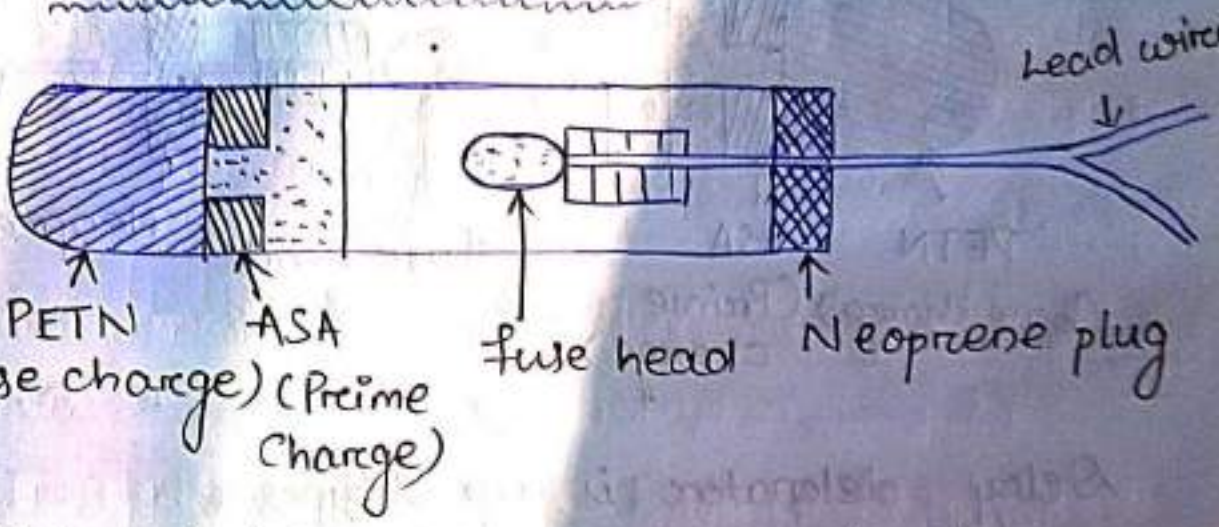
Plain Detonators

A plain detonators is a 'Al' tube of 6mm diameter & 37-50 mm long & filled with ASA composition & PETN in one third part of tube.

The ASA composition consist of a mixture Lead asized (A), Lead styphnate (S) & 'Al' powdere (A).

The ASA composition is used as preime charge as it start initiation system at 1st stage in the Process of blasting & PETN (Penta Erythrito Tetra nitrate) used as base charge in a detonator it is more powerful explosive with a VOD more than 7000 m/s.

Ordinary electric detonators



Ordinary electric detonators are of 2 types

i) Low tension detonators

ii) High tension detonator

Low tension detonators are generally use in mines where as high tension detonators are more powerful are not use in mines purpose.

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

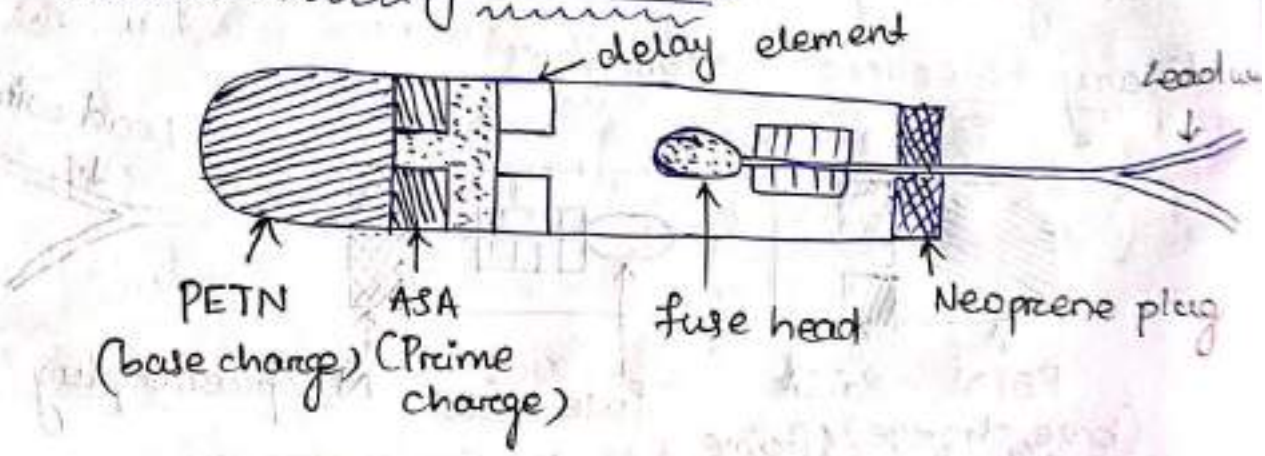
A cupper or 'Al' tube have PETN as base charge & ASA composition as preime charge & occupies 1/3rd of tube length

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 fuse head is 0.5A & can be blasted with a minm voltage 3.5V the resistance of low

tension detonatore with a 45m short firing arcround 7 Ω.

The continuety of circuit of low tension detonatore is tested by Galvanometere.

iii) Electric delay Detonatore



Delay detonatore is up 2 types

i) half second / long delay detonatore
ii) Mili second / Short delay detonater

The delay detonatore have a delay element Provided between prime charge & fuse head.

The delay element consist of 'cu' or brass Sleeve filled with antimony & potassium Permanganet. In case of short delay detonatore red 'si' or lead can be use as delay element.

The fuse head consist of flashing material Lead mononitro resourcial (LMNR), KCl charcoal etc.

The delay detonatore & non electric delay detonatore can be -

distinguish by a colour of lead wire which are projected & the delay no. in delay detonator are stamped at buttom of tube

Permission from DGMS is needed before the use of delay detonatore. During storage delay & non delay detonatore can't kept in same box.

Advantage of delay detonatore

→ Reduce consuption of explosive as blasting is more efficient due to avaiablity of free space fore each row.

→ freagmentation is bettere

→ The mili sec. delay detonatore produce less ground vibreation.

→ More time is saved as fire ore short is within a fraction of second.

Safety fuse

24-21/05/2019

It consist of a core of fine grained gun powdere. wrapped with plastic tape & watere Proof coating. The burning speed is usually 100-120 sec/m.

When one end of the fuse is ignited it carries the flame at a uniform rate to ignite the detonatore.

Generally the length of safty fuse use in ordinary detonatore is 1.2 M.

It is manufacture in differend brand to use in differend condition.

Manufacture brand		Condition
Double bull brand	⟶	Dry condition
Blue Sump	⟶	Damp condition
Orange colour sheath	⟶	Wet cond"/ ragged

D. cord / detonating cord

The detonating fuse looks like a plastic cord having external diameter 5mm & weight 20 gm/m.

It has a VOD of 7000 m/s

It is instantaneous in it's action.

Detonating cord is filled with PETN as it's core. It is also available in trade name 'condex'.

To initiate the explosive by ordinary detonator it provides the rate of propagat which is explode the detonator as well as explosive cartridge.

Non-el (non-electric detonator)

The nonel system of detonation by Noble AB of Swiden.

It is a flexible plastic tube having external dia & 1.5 mm internal diameter. The tube are available in free cut end, one of which is fitted with non-electric delay detonator where as the other end is shield

During blasting the end having detonator is lower into the blast hole where as the shield end is projected outward & initiated by a

detonatore itself.

The advantages of nonel is to provide stedy curercent & protect the blasting from radio transmission, friction, flame etc. so it is a measurce against misfire.

It also produce less ground vibration & eleminate electrical circuit testing.

RAYDET

It is a non-electric initiation system which combine the advantage of electric detonatore & detonating cord.

It consist of plastic tube carercies a small quantity of explosive matereial in its inere surface.

A high strength no.8 instanteneous ore delay detonatore is crimped to one end of ray tube.

When Raydet is initiated by detonatorc the ray tube having explosive carercies the rays of Propagation so that continuety of VOD is maintained.

The Ray tube is available in 3to 45m which can eleminate the need of ⊘-cored with in a shoret hole.

It has in the forem of zereo delay to no. 15 delay ray tube formation to give the advantage of delay detonatore.

Detonating Relay

In open cast worcking detonating relay Provides a non-electric delay firing system. This method avoid electric connection. which is requireed to blast a delay detonatore.

A detonating relay is a flexible tube whose one end have a delay detonator & the other end have a non-electric detonator & connected via a detonating fuse inside the tube.

Both the end of tube is open to receive the detonating fuse which is need for initiat Here the delay tyme varies bet? 15 to 45 mili sec can be use in a series connection blasting partten

EXPLODER

Explodere is portable apparatus which Provides the currerent necessary fore firing electr detonatore is called an explodere

It is off following type.

i) Dynamo explodere / Magneto explodere
ii) Battery explodere
iii) Condensere dynamo explodere

Dynamo Explodere

It consist of a permanent steel magn between the poles of which an armature revolves by that rack & pinion method.

The voltage generated depends upo the speed of armature which creat magnetic flux & emf is generated.

A low tension exploder gives a voltage about 15 V.

A high tension explodere gives 125 V.

The exploder used in U/G coal mines is of intrinsically safe apparatus.

Battery exploder

The current in battery condenser exploder is provided from a Battery of 4 or more dry cell connected in series.

Each battery give 1.5 V.

It can be operated diattachable key.

The company which produced the battery condenser exploder as a trade mark Rhino exploder.

By this exploder 3 no of shots can be fired at a time.

When using the exploder the two wire of shot firing cable are connected the terminal of exploder then the key is inserted & rotate clockwise to provide current to electric detonator.

A neon lamp glow 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. with in a magnetic field.

This is manufacture by Narendra & co. company. It is suitable for coal mines having less inflameable gases.

Crimper

A crimper is a paid of pliers to crimp or Press the end of a plain detonator tube on a Safety fuse inserted into it so that the fuse cannot come out of the detonator. It is dangerous to crimp the tube and with teeth.

Circuit Testere

In electric shot firing before any attempt is made to fire the shots, the circuit is some times tested to make sure that there is not open or short circuit. Such testing should be ~~limited~~ done by approved apparatus and it is important that the current passed during testing should be limited.

All testing must be done from a safe Place and safe distance from the blast site.

An instrument to test countinuity of an electric circuit for blasting is the blastometer manufactured by IDI. Chemicals Ltd. It is an electronic solid state circuit tester and is available in two ranges.

i) 0 to 100 ohms for underground coal mines
ii) 0 to 100 ohms for others applications.

01-22.08.2019

Stemming Rod

It is a non-metalic rood used to push the cateries of explosive into the short hole.

Length and height of overburden

In opencast mining part of overburden remove above the economic mineral has to be dumped outside.

A judicious dumping of the same ensure saving in ground and chance of any slide back or dangerious incident in future

While very low height and flat dump should be idea from the points of stability these couldn't only occupy lots of ground

space what also very expensive.

Hence a balance has to be struck maximum flow with minimum possible ground space to occupy while ensuring that dumps do not slide and doesn't cause any accident.

Ex- Dimension of overborden no. 2 joint ocp.

total length = 460m

Top bench height = 20m

Bottom bench = 24m

bench width = 4m

Surface area covered $4450m^2$

Dt-22/08/2019 **Drilling in Surface Mining**

Chapter-5.

Surface mining start with cutting of trees, clearing of bushes & removals of soil and subsoil.

Soil is a valueable constituent of earth Surface need to be scarped and stored put of working tool for use in future for reclamation.

overburden & ore Fragmatation

formation below soil and weathere & rock needed breaking by way of drilling & blasting in case of cycle mining.

This was done in stages dividing the total bourden ore overe burden in platform at different levels by way of bench formation.

The height of the bench in a hard rock shouldn't exceed 7.5 mtre and the side of the bench should be slow at an angle not more than 60° from the horizontal.

The bench dimension may be increased for the dip hole blasting.

Height of the bench in overborden ore ore body couldn't be more than the digging height of the basine used for digging.

The width of the bench shall not be less than the width of the widest machine & the bech height.

Exploratory Drilling

Drill holes or bore holes used for exploration are usually narrow through they have been drill down to a great depth.

Most of the exploratory drilling is generally done on the surface through underground exploratory drilling is frequently used for exploring the lateral extent of ore body and Presence of parallel ore bodies from suitable underground excavation.

Undergreound drill force can also be use to explore the habitate extent of ore bodies to a limited extent.

They substansially reduce the cost of exploration as compared to surface dreill hole by cutting down the length of hole.

Exploratory drilling is used for

i) locating deposists hidden under soil, rock, or water cover.

ii) Proving the extent of ore bodies pose in left hand laterally.

iii) Searching for the distance of other ore bodies near by.

iv) locating faults and other structural features.

v) collecting samples for the estimation of made and reserve.

Methods of exploratory drilling

Method of exploratory drilling can be broadly classified into two major group.

i) Percussibatory drilling

ii) Rotary drilling

On the basic of powere used they can classified as manual or mechanical.

Heavy ANFO (HANFO)

The latest development of 1980 had been the use of emulsion slurries mixed with different proportion of ANFO to give water resistent and higher density mixture which are named as Heavy ANFO or HANFO

→ The emulsion to ANFO ratios can be from 20:80 to 50:50 depending on the severity of water conditions & need of stronger blast energy.

→ HANFO gives the advantage of lower cost like ANFOR with higher density, hoger energy and better water resistance than ANFO or AN.

→ Thus the mixture can have bulk density from 1.10 to 1.25 gm/cc (compared to ANFO 0.8gm/cc) and bulk strength almost 45% more than ANFO.

→ The higher energy ANFO through HANFO system or slurry concentrates system allows expansion of drilling pattern, thereby reducing drilling costs.

Explosive & Accessories

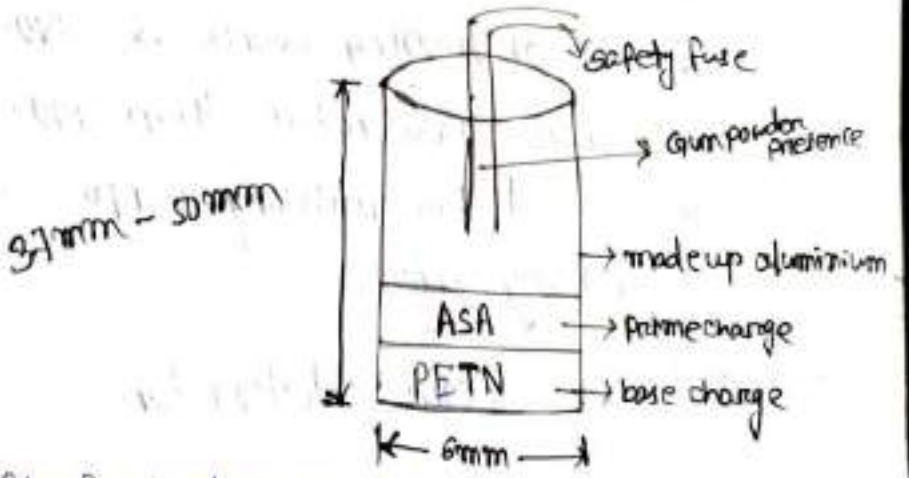
(*) Detonators :- High explosives are initiated by detonators or detonating fuses.

→ A detonator is a small copper or aluminium tube containing essentially a small auxiliary charge of special explosive.

→ A chemical reaction is initiated by a flame or electric current. in the special explosive can build up very rapidly into an explosion of sufficient intensity to project a detonation wave throughout a high explosion enclosing the detonator.

Detonators are of the following types

(i) Plain detonator :-



→ It is fired by safety fuse, the spark or "spit" from the fuse causing the detonator to explode.

→ These are also called "ordinary" detonators.

→ A plain detonator simply of an aluminium tube of 6mm dia & 37mm - 50mm long, It filled with 1/3 with ASA composition & PETN (Penta erythritol tetranitrate).

→ The ASA composition consists of a mixture of lead sized (A), lead styphnat (S) & a little "Al" powder (A).

→ The ASA composition is used as a primary charge as it starts initiation system at first stage in the process of blasting.

→ The PETN used as a base charge in a detonator as it is more powerful explosive with VOD more than 7000 m/s.

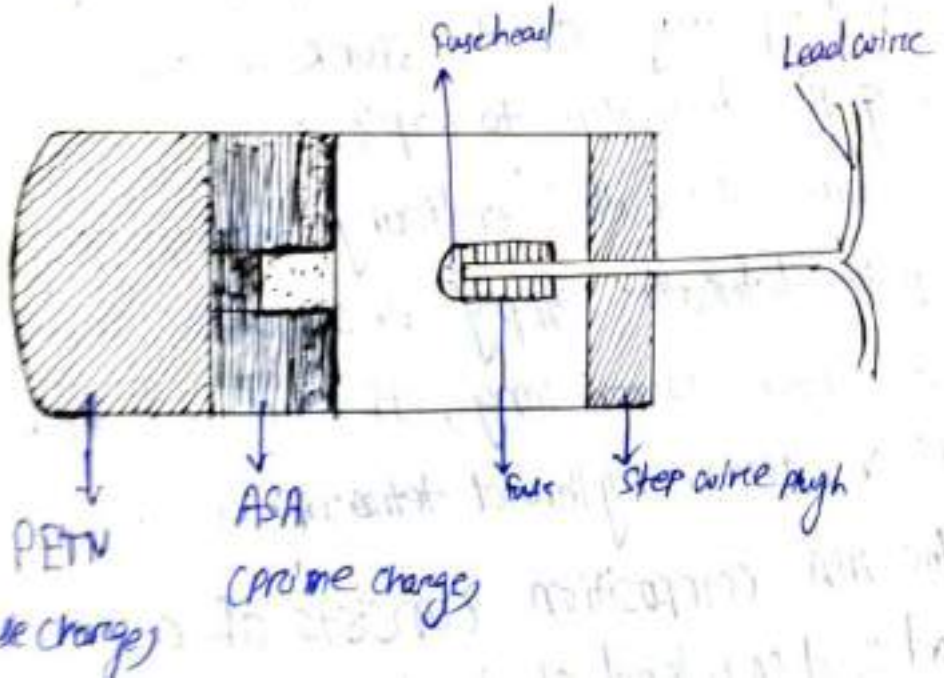
→ The plain detonator or ordinary detonator are of instantaneous type & needs a safety fuse for its fire.

→ plain detonator is available in two forms.

(i) NO.6 detonator & (ii) NO.8 detonator.

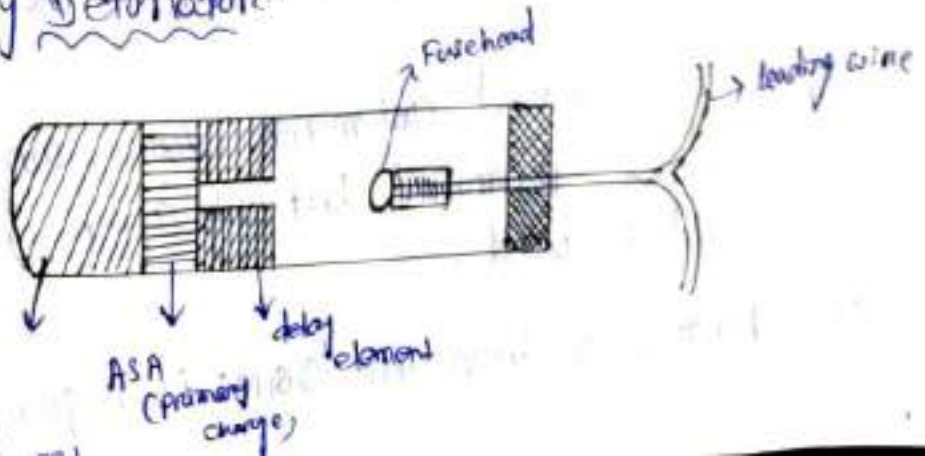
→ NO.6 detonator is suitable for normal requirements of mining work & NO.8 detonators are more powerful than NO.6. NO.8 detonators are used in military purpose in war but not in generally used.

(ii) ordinary electric detonator



→ These are fired by the passage of electric current through the detonator.
→ They are of two types
(i) Low tension detonators
(ii) High tension detonators
→ Low tension detonators are generally used in mines where as the high tension detonators are more powerful but not for mining purpose.
→ The ordinary electric detonator are of instantaneous type that is without any delay element.
→ A copper or Aluminium tube have PETN as base-charge & ASA composition as prime charge & occupies $\frac{1}{3}$rd part of the tube length.
→ Electric detonator is not fired by ignition or safety fuse, but passing electric current through a fuse head it is fired.
→ The current required for the iginitation of fuse head is 0.5 A & can be blasted with a minimum voltage of 3.5 volt.
→ The resistance of low tension detonator with a 45 m short firing cable is around 7Ω.
→ The continuity of the circuit of low tension detonator is tested by Galvanometer.

(ii) Delay Detonator



→ These are essentially low tension electric detonators with a delay element.

These are of two types

(i) Half second delay detonator (or) Long delay detonator
(ii) Milli-second delay detonator (or) short delay detonator

→ A delay detonator has a delay element which is placed in between the fusehead & the primecharge

→ The delay element consist of a copper or brass sleeve filled with special composition (Antimony & ~~potassium permanganet~~) which burns at a specified rate & the delay is obtained by varying the length of the sleeve containing the special composition.

→ In case of long delay detonator Antimony & potassium permanganet is used as delay element

→ In case of short delay detonator red silicon or lead can be used as delay element.

→ The delay detonators & non-delay detonators are distingwished by the colours of lead wired.

→ The delay period is marked on a tage attached to the wires.

→ The delay number is stamped on the bottom of tube.

→ In underground coal mines aluminium detonators are not permitted but only copper detonators should be used.

→ Permission from the DGMS is required before

using delay detonators in underground coal mines.

→ Delay detonators & non delay detonators should not be kept in the same box.

Advantages of Delay Detonators

(1) Reduced consumption of explosive as blasting is more efficient due to availability of a free face for each row.

(2) Fragmentation increased & easy in loading the rock.

(3) The whole round of shorts is fired in a fraction of a second & time will saved.

(4) The millisecond delay detonator produces less ground vibrations than the half second delay detonators.

Safety fuse

→ Safety fuse looks like a cord.

→ It consist of a core of fine grained gun powder wrapped with layers of plastic tape & water proof coating.

→ The burning speed is usually 100 to 120 s/m.

→ When one end of the fuse is ignited, it carries the flame at a uniform rate to ignite gun powder or to detonate an ordinary detonator.

→ Generally the length of safety fuse used in ordinary detonator is 1.2m.

→ It is manufactured in different brands to use in different condition.

Double bull brand ——→ For dry condition

Blue stump ——→ For damp condition

Orange coloured plastic seathed (OCPS) & Blue plastic ←—→ For wet & very rugged condition.

Detonating fuse :

The detonating fuse is looks like a plastic cord.

→ Its external dia is 5 mm & weight about 20 g per metre length.

→ It has a velocity of detonation of 6500 m/sec.

→ It is instantaneous in its action.

→ Detonating cord is filled with PETN within its core.

→ The fuse is completely enclosed in a tubular cover of plastic material.

→ It is also available in the trade name cordex

→ TO initiate the explosive by ordinary detonator it provides the rate of propagation which will explode the detonator as well as the explosive charge

→ A large number of shots connected to a safety fuse for blasting with a single detonator.

* Nonel

→ The nonel system of detonation is developed by Nobel AB of sweeden.

→ Nonel means non-electric detonator.

→ It is a flexible plastic tube, having 3mm external diameter & 1.5 mm internal diameter.

→ The tubes are available in pre-cut length, one end of the tube is fitted with a non-electric-delay detonator & the other end is sealed.

→ During blasting the end having detonator is lowered down in the blast hole while the sealed end projected outside the hole.

→ The sealed end is initiated by a detonator or detonating cord.

→ The advantages of the Nonel system lies in its extreme resistance to accidental initiation by static electricity, stray current, & protected the blasting from radio transmission, flame-fraction etc.

→ It eliminates the need for complicated electrical circuit testing & short-firing equipment.

* Raydet:-

→ Raydet is a non-electric initiation system which combine the advantages of electric detonator & detonating cord.

→ It consist of a plastic tube carrying a very small amount of explosive material on its inner surface.

→ A high strength TOS instantaneous or delay detonator is crimped to the end of the raydet.

→ When the raydet is initiated, a low order shock wave travels through the tube & initiates the detonator.

→ It can be initiated by a detonating cord / detonator.

→ A tag indicates the delay number of raydet and a tape fastening the tube in a coil indicates the tube length.

→ The length of the tube varies from 3m to 9m which can eliminate the need of cord another a shothole.

→ The delays are from no. 0 delay to no. 15 delay. NO. 0 delay is instantaneous, NO. 1 delay is 50 ms & NO. 15 delay is 625 ms.

Detonating relays :-

→ In opencast working, detonating relays using detonating fuse for initiation provides non-electric delay firing system.

→ This method avoids the electric connection which are required to blast a delay detonator.

→ A detonating relay is a flexible tube whose both the end have delay detonators & the detonators are connected by a detonating fuse inside the tube.

→ Both the end of the tube is open to receive the detonation fuses which is needed for initiation.

→ The delay interval for each detonating relay

varies from 15-45 millisecond.

Exploder

It is a portable apparatus which provides the necessary current for firing to the electric detonator, is known as exploder.

→ It is safer, quicker, & more convenient for electric shot firing than ordinary fuse firing.

→ It is of three types :-

(i) Magneto (or) Dynamo Exploder

The magneto exploder consist of essentially a permanent steel magnet in between the poles of which revolves an armature rotated through gearing by rack & pinion.

→ The value of voltage depends upon the speed at which the armature revolves & the flux created by the magnets.

→ A low tension exploder gives a voltage about 15 volt.

→ A high tension exploder gives a voltage about 125 volt.

→ The magneto exploder fires only 1 or 2 shots at a time with a single shot exploder.

→ The magneto or Dynamo exploder should be intrinsically safe for underground (U/g) coal mines.

(ii) Battery condenser Exploder

The current in battery condenser exploder is provided from a battery of 4 or more dry cell connected in series.

→ Each dry cell giving an emf of 1.5 volt

→ It is 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

→ In Rhino-25 the firing current is 1.5 amps input D.C is 6 volt, output DC is 600 volt & Duration of firing current is 5-4 milliseconds

(iii) Condenser Dynamo exploder

These are manufactured by Narendra & Co.

→ The machine is suitable for operation in places where inflammable gas does not constitute a hazard.

These are available in three types in the market

(i) CNT 50 to fire 50 detonators connected in series
(ii) CNT 100 to fire 100 detonator in series
(iii) CNT 200 to fire 200 detonator in series.

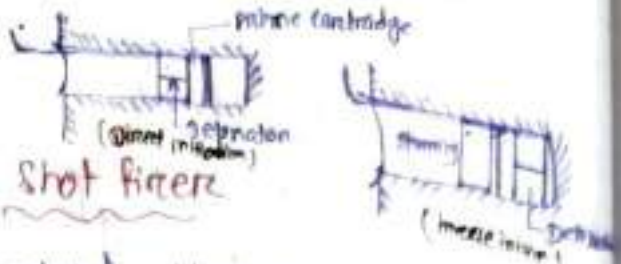
Charging A shot hole

→ At first a cartridge of non-combustible stemming material is pushed in the hole.
→ After that the charge is placed in the hole & at last the prime cartridge pushed into the hole.
→ The cartridge consist a detonator.
→ when the business end of the detonator point towards the main body of the charge, this position of primer cartridge is termed as direct initiation.
→ when the detonator is at the back of the charges and the "business end" point towards the front of the hole, it is called inverse initiation.
→ Direct initiation is best to prevent ignition of fire-damp, reduces risk of blow-out shots, and gives maximum yield of coal having a free face.
→ Inverse initiation is adopted in stamping or "cut" shots in shafts and tunnels. and when using delay action detonator to fire a round of shots.
→ After the charge is placed in the hole, the shot hole is stemmed with stemming material.
→ Keeping ends of the leading wires of detonator

out of the hole.

→ The stemming material ~~is tamped~~ consists of sand & clay in a ratio 3:1

→ The stemming material is tamped lightly near the explosive charges and tamped hard near the mouth of the hole.



Complete procedure for shot firer

The whole procedure which the shot firer has to follow to fire shots using electric detonator are

1. Test short holes for breaks, if a crack is found then the hole shall not be charged.
2. Test the gas eruption from the hole & within 8 m of the hole.
3. see that the shot hole is 150 mm less than the depth of the cut, if a coal cutting machine is used.
4. Mark the direction of the shot hole on the roof or side where practicable.
5. Charge the hole with explosive, insert the primer last of all. Don't force a primed cartridged into a shot hole of small size.
6. First stem the hole lightly & then hard upto its mouth.
7. Spray stone dust or waters within 18 m of the area.

8. warn the workers to clear up the place & post the helpers to a suitable place 2m away from the blasting side to prevent the workers inadvertently entering the area.

9. Lay out the shot firing cable.

10. Test again the presence of gas within 15m.

11. Couple the firing cable ends to detonator wires. If more than one shot is to be fired, all connections of detonator leads should be in series.

12. Take shelter.

13. Couple shot firing cable ends to the exploder

14. Shout a warning again; ensure that workers have taken shelter, and fire the shouts by a sharp twist of the exploder key. If the charge does not explode, try again with a sharp twist of the exploder key.

15. Allow the fumes and gases to clear.

16. Return to the shot hole, examine the roof, sides and timber supports and shout "all clear". Fore the workers to return to their work if the place is safe.
Otherwise have it dressed by dressers, and supported by timbermen before workers enter it.
At the end of the shift the shotfirer should write a report about the quantity of explosives blasted and the place of blasting.

Secondary blasting :-

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

It is of three types :-

(i) pop shooting
(ii) plaster shooting
(iii) snake blasting

(i) **pop shooting** :- In pop shooting a hole is drilled by jackhammer for charging with explosive and blasting the boulder.

~~Normally a depth of 0.3 to 0.6 m is~~

→ The depth of the whole is normally 0.3 to 0.6 m which is sufficient for the blasting of the boulder.

→ A small quantity of explosive cartridge is placed in shot holes with proper connection and allowed to stemmed.

→ By connecting each leading wires of a round blasting is done to found well fragmented ore or mineral.

(ii) **plaster shooting** :- In plaster shooting the explosive which is use consisting a single primed cartridge or a few cartridge.

→ At first the surface of the boulder is cleaned up to free it from dust then a small quantity of explosive is placed over the boulders.

→ Then it is covered by clay & it is pressed by hand.

→ It is advantageous to wet the surface of the stone before plastering and the clay should be well pressed down for good contact with stone round the explosive.

→ Special gelatine, or Ajax G can be used for the blasting.

→ With the helpof detonator the boulders are allowed to blast for a well fragmented ore.

(iii) Snake blasting / Toe blasting

In snake blasting the catridges are placed beneath the boulders and with the help of detonators, it is blasted to found well fragmented rock.

Blasting Patteron

The various types of blasting patteron are

1. Deck blasting / Charging.
2. Chamber blasting
3. Muffle blasting
4. Cushion blasting
5. Simultaneous blasting
6. Pre splitting.

Deck charging :-

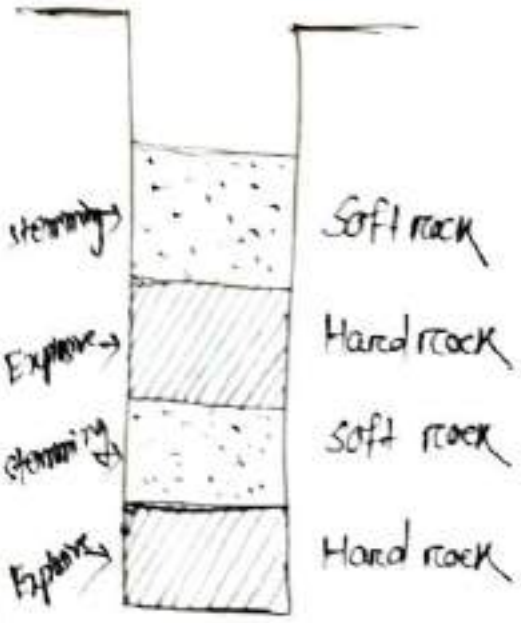
This type of blasting pattern is generally used which alternate hard rock and soft rock formation are their in a drill hole.

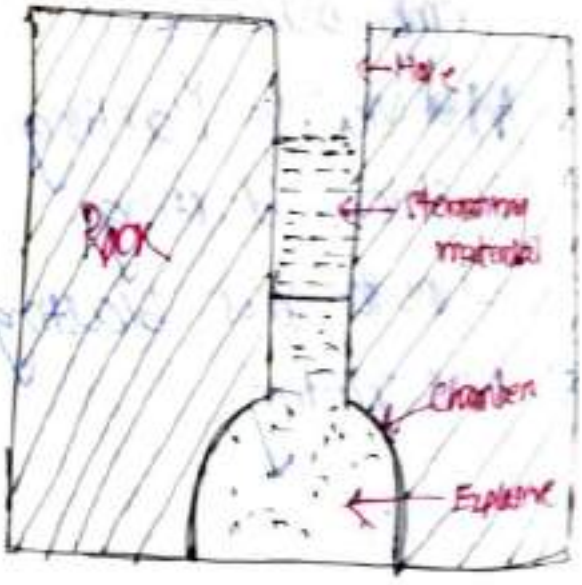
→ In this method, the explosive are placed at hard rock layers & ~~stemming~~ stemming or spacing by aire bags at soft rock layers.

→ The total quantity of explosive needed for a shot hole is divided in quantity and placed in the length of the shot hole.

→ Generally 2/3rd of explosive are placed at the bottom of the hole and 1/3rd of explosive is used in other layer of hard rock formation.

→ Rest of the length of the hole is stemmed by stemming material.





(Deck blasting)

2) Chamber blasting :-

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

→ In this method of blasting, the bottom of the hole is widened by inclined drilling.

→ By which the maximum amount of explosives are placed at the bottom of the shot hole.

→ A sufficient space is provided for stemming.

→ It prevents misfire or blown out of shots.

3) Muffle blasting :-

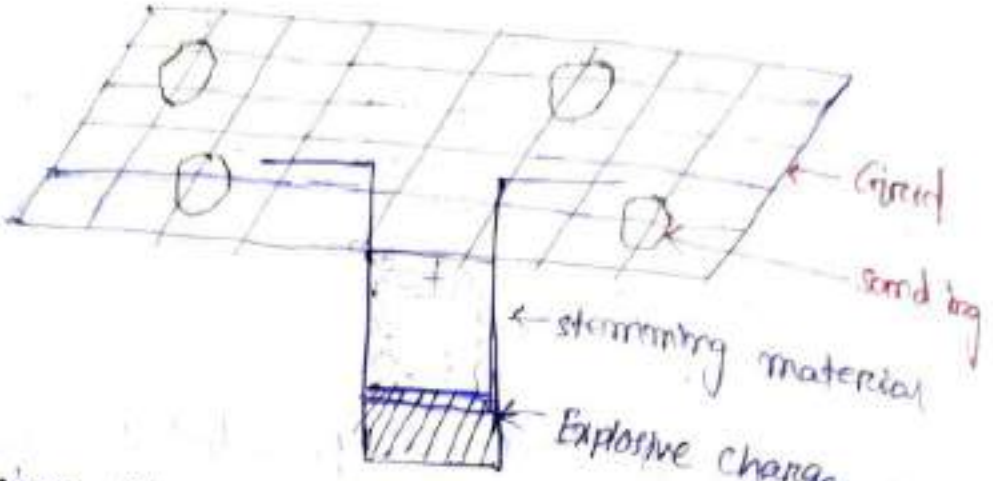
Muffle blasting is generally practised when the mines is near about a public road (or) populated area.

→ This method is practised to prevent the formation of flying rock.

→ In this method the drill holes are covered up by the strips of iron rod & sand bags.

→ The iron rods are placed in criss-cross manner & the bags are placed over the iron rod to form mesh.

→ If blasting occurs then the flyrocks are restricted to the blasting area only.



4) Cushion Blasting :-

→ When the aim of the blasting is to get lumpy coal ore to minimise the formation of of coal dust then this type of blasting is done.

→ In cushion blasting low density high explosives are used.

→ In this blasting the hole is first charged with explosives.

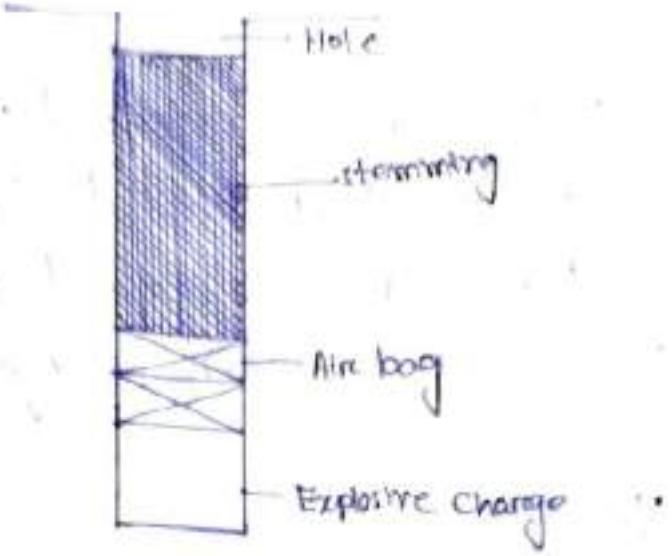
→ After charging the explorives one or two air bags are pushed into the holes.

→ Remaining length of the hole is stemmed by stemming material.

→ At first stemming is done tightly but at last it is done very tightly.

→ The air bag in the hole are acts as cushion.

→ such blasting with air gap is known as cushion-blasting.



5) simultaneous blasting

→ when number of holes are blasted at a time at a given place, such blasting is known as ~~cushion~~ simultaneous blasting.

→ In this blasting all the holes are cleared off the cutting.

→ The holes are charged with explosives with low tension electric detonators.

→ In this blasting generally series connection is done.

→ Generally simultaneous blasting is practised in opencast mines.

Advantages

i) The blasting of the hole is carried at one time.

ii) Larger time are save as compared to single hole blasting.

(iii) Efficiency of blasting is more.
(iv) Less amount of explosive is required.

Disadvantages :-

(i) Misfires are not detected in such blasting.
(ii) Coal dust is produced in large amount.
(iii) Large area is exposed at one time.
(iv) Weak roof is further destroyed.

(6) Pre splitting

- Now-a-days pre-splitting type of blasting is generally preferred as well fragmented ore can be found by providing delay time between number of shots.

→ For this purpose a delay detonator is used.
→ It has several advantages
(i) Less consumption of explosive.
(ii) Less ground vibration.
(iii) Eliminate secondary blasting.

MAGAZINE

Defination :-

A building where explosives & detonators are stored is called a magazine.

→ A magazine construction must be afforded by inspector of explosives.

→ The magazine should be constructed in a site, which must be at a specified distance from public roads and residual quoters.

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

1. Gun powder
2. Nitrate mixture
3. Nitro compound
4. Chlorate mixture
5. Saftey fuse.
6. plastic igniter cade & Detonating fuse etc.

Procedure for establishing a magazine

An application in the form of 'c' & '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 license in form 'E' then the 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 license From Chief controllere of explosive and should be located at a safe distance from,

1. From all buildings, temples, office, schools factories apart from 45 m.
2. From all roads, rivers, playgrounds and market apart from 48 m.
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 it can be constructed (5m x 3m) area in a steel cabin like structure.

→ Maximum 100 to 200 detonators can be stored in a portable magazine at any time

Large Magazine :-

A Large magazine is constructed at remote place with a safe distance from all important buildings, roadways and public access points.

→ A large magazine is constructed with bricks and cements and have separate cubicles for storage of explosive boxes, corder, detonators safety fuse at separate points and the building is protected from weathering action and lightening arrester.

→ The building is in a well ventilated place

→ It is secured by security person for non access of public and a register is maintained for explosive in magazine that how much explosive & accessories are left & how much will return.