:::::::::::::::: Drilling and Blasting with CSEP (Comprehensive student enhancement pattern)::::::::::::::::



DRILLING & BLASTING



HEARTFELT THANKS TO:

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Student Details

2017-18 Onwards (MR-17)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	B. Tech IV Semester		
Code: 72504	DRILLING AND BLASTING	L	T	P
Credits: 3		3	-	-

MODULE-I:Principles of Drilling and Drill bits **09Periods**

Principles of drilling: Principles of rock drilling, drillability, drillability index, factors affecting the drillability, selection of drills.

Drill Bits: Various types ofdrill bits, study of bit life, factors affecting bit life, Thrust feed and rotation

MODULE-II:Explosives **09Periods**

Historical development, properties of explosives, low and high explosives, ANFO, slurries, Emulsion explosives, heavy ANFO, permitted explosives, testing of permitted explosives, bulk explosive systems-PMS, SMS, substitutes for explosives and their applications- hydrox, cardox, airdox.

MODULE-III:Firing of Explosives and blasting methods **09Periods**

PART-A: Firing of Explosives: Safety fuse, detonating cord and accessories, detonators, Exploders, Electric firing and non-electric firing, electronic detonators, NONEL blasting.

MID EXAM 1

PART-B: Blasting methods: Preparation of charge, stemming and shot firing, choice and economical use of explosives, misfires, blown out shots, incomplete detonation, their causes, prevention and remedies.

MODULE-IV:Handling of Explosives **09Periods**

Surface and underground transport of explosives, storage and handling of explosives, magazines, accidents due to explosives, precautions and safety measures during transportation.

MODULE-V: Mechanics of blasting and effects of blasting **09Periods**

Mechanics of blasting:factors affecting rock breakage using explosives, theory of shaped charge, detonation pressure, coupling, shock waves impedance, critical diameter.

Effects of blasting:vibrations due to blasting and damage criteria, fly rocks, dust, fumes, water pollution and controlled blasting.

MID EXAM 2

TEXT BOOKS:

1. Blasting in ground excavations and mines, Roy Pijush Pal, Oxford and IBH, 1st ed 1993
2. Drilling technology handbook, C.P. Chugh, Oxford and IBH, 1st ed, 1977 .

REFERENCE BOOKS:

1. Rock blasting effect and operation, Roy Pijush Pal, A.A. Balkema, 1st ed, 2005
2. Elements of mining technology, Vol-1, D.J. Deshmukh, Central techno, 7th ed, 2001
3. Blasting operations, B.Hemphill Gary, Mc-graw Hill, 1st ed 1981

MALLA REDDY ENGINEERING COLLEGE(Autonomous
Department of Mining Engineering

Class TimeTable **Class Room:ME-205**

Academic Year : 2018-2019

Class : B.Tech. MIN.- II Year / II Sem **With effect from: 17.12.2018**

Period	I	II	III	12:30 – 1:15	IV	V	VI
Day/time	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30		1:15 - 02:15	2:15 - 3:15	3:15 - 4:15
Monday		D&B		LUNCH			
Tuesday			NPTEL/D&B				
Wednesday							
Thursday							
Friday							
Saturday					D&B • Comprehensive Scrutinizes(3) • Prototype Replicas(2) • Journal Interpretations(5) • PPT Talks(5)		LIBRARY

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Day/time	9:30 - 10:30	10:30 - 11:30	11:30 - 12:30		1:15 - 02:15	2:15 - 3:15	3:15 - 4:15
Monday	P&S	D&B	GS	LUNCH	MOS	MM	MOS
Tuesday	MS	P&S	NPTEL/D&B		LE	SMT	GS
Wednesday	MOS	LE	P&S		MS	GS	MM
Thursday	SMT	MOS	MM		MS -I , Lab / MOS-LAB		
Friday	MM	SMT	P&S		MS -I , Lab / MOS-LAB		
Saturday	P&S	MS	SMT		D&B		LIBRARY

IMPORTANT/GUESSED SHORT QUESTIONS

UNIT-1:

1) Explain briefly Drillability index.*
2) List out various names of Drill bits.*
3) What are the major principles of rock drilling?
4) Write short notes on types of drilling.
5) Explain about feed mechanism.
6) Explain about screw feed mechanism.

UNIT-2:

1) Define explosive?*
2) What is difference between SMS and SME?
3) What is hydrox and airdox?
4) What is difference between ANFO and HANFO?
5) What is difference between Slurry and Emulsion?*
6) What are the Permitted and non-permitted explosives?

UNIT-3:

1) What is difference between safety fuse and detonating cord?*
2) Explain types of detonators?*
3) Write short notes on misfires.
4) Write short notes on blown out shots?
5) Write short notes on initiation systems?
6) Explain blast hole charging and stemming?

UNIT-4:

1) Write short notes on handling of explosives?*
2) Explain about mine magazine?*
3) Mention required precaution to be taken while explosive transportation.
4) Write about explosive vehicle as per regulations.

UNIT-5:

1) Explain rock breakage mechanism in brief.
2) What is shaped charge?*
3) What is critical diameter?*
4) Explain about fly rocks?
5) Explain about dust fumes and water pollution due to drilling and balsting
6) Explain briefly about impedance and shock wave?

IMPORTANT/GUESSED ESSAY QUESTIONS

UNIT-1:

1) Explain the factors influencing the drillability of rock, with suitable examples.*
2) What is the principle of rock drilling? Explain Rotary-Percussive drilling with neat illustration.
3) What is are the factors affect Drill bit life? What are the different types of drill bits*

UNIT-2:

1) What are the properties of explosives? Explain major variation between High and Low explosives?*
2) Explain the difference between slutty and emulsion. Among which one is most opted explosive?
3) List out importance of bulk explosive systems.
4) Explain following
   (a) Hydrox
   (b) Airdox
   (c) Cordox.
5) Explain importance of permitted explosives in underground mines?*

UNIT-3:

1) Explain following
   (a) Safety fuse
   (b) Nonel
   (c) D-Cord

2) Explain types of detonators? Explain any one with neat sketch*
3) Prepare a blast hole with following information.
   (a) Length of the hole 14m
   (d) Diameter-Assume according to length of the hole
   (c) Loose strata

** Charge-Stem the blast hole in suitable manner, if any matter required, can be assumed.

4) Explain following
   (a) Mitigation of Misfires
   (b) Mitigation of Blown out shots

UNIT-4:

1) Explain in detail, Transportation & handling of explosives.*
2) Explain the constructional features of magazine?

UNIT-5:

1) Explain rock breakage mechanism using explosives?
2) Explain ground vibration causing due to blasting?*
3) Discuss briefly about fly rock and its mitigation.
4) What are the controlled blasting techniques?*
5) Explain dust fumes, water pollution caused due to blasting?

5/11/18

Unit-1

Principles of Drilling and Drill Bits

Drilling of rocks for blasting is an Essential requirement, to break medium-hard and the hard rocks. Drill holes for blasting can be small (40-65mm) or large (65-300mm) diameter. Large holes of over 800mm diameter have been drilled for the raises in underground mines.

The selection of the drill machine is very important to match desired drivage and optimization of drill hole parameters for Better Blasting results.

Principles :

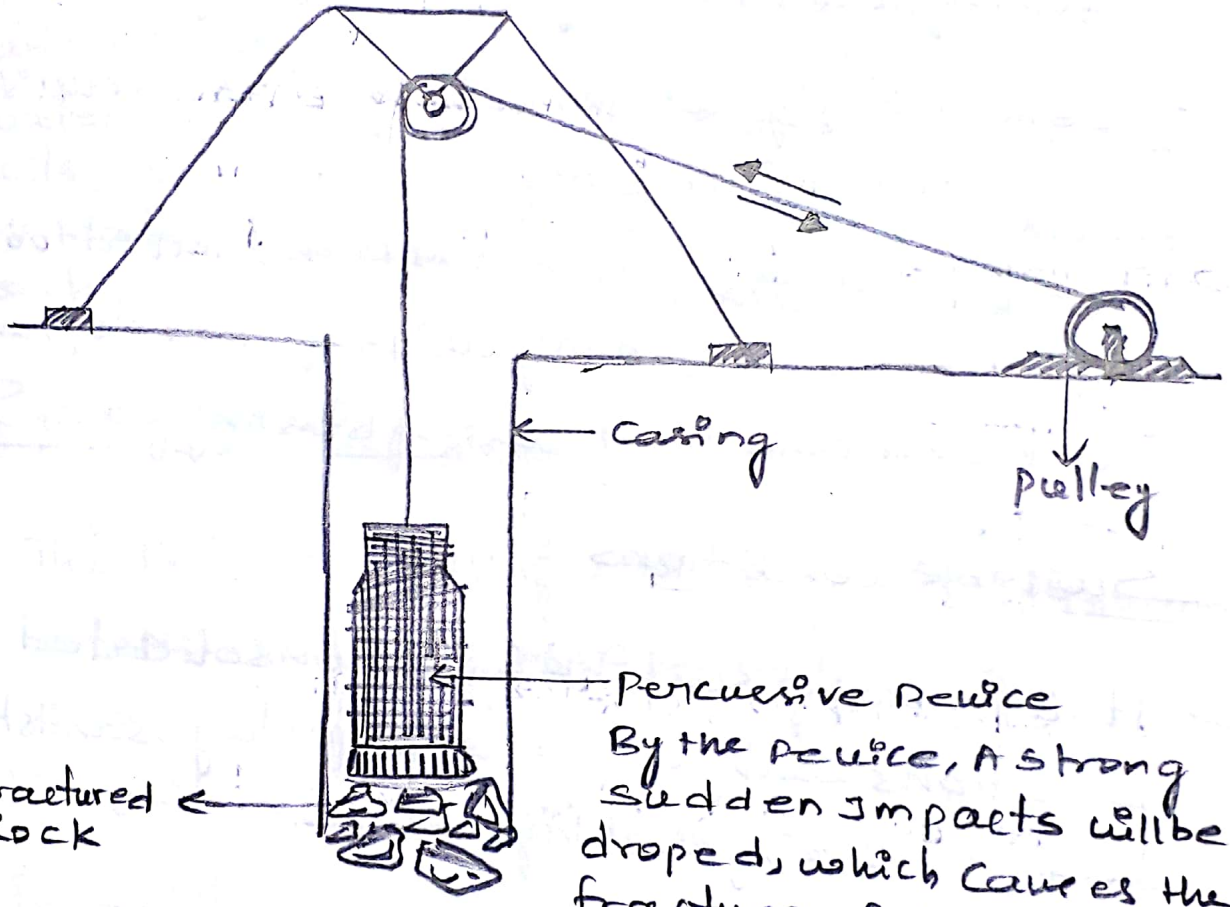
- Percusive Drilling
- Rotary Drilling
- Rotary-percutive Drilling

Depends on power transmission :

- pneumatically operated
- Hydraulically operated
- Electrically operated

Percussive Drilling :-

- Here it penetrates rock by the successive impacts applied through chisel bit.
- The bit rebounds and an impact again after rotating slightly thus every time hammering a new face and maintain a circular shape of hole.



- The stress effective in breaking the rock acts in an axial direction and in a pulsating manner.
- Under the action of these impacts, the rock is elastically deformed with crossing of the surface irregularities.

- Then main sub-surface cracks are formed, these are radial cracks from the edge of Bit, at the edge of Bit, wedge shaped is formed.
- This leads to the formation of the rock chips which are removed by the cleaning action of any circulating fluid.
- The two predominant mechanisms in the percussive Drilling are Crushing and Chipping.
- Comparitively with the Rotary, Its (percussive) plays very minor role
- The percussive applications are limited to a small mine, secondary drilling, Development work and and wall Control Blasting.

Suitable Conditions :

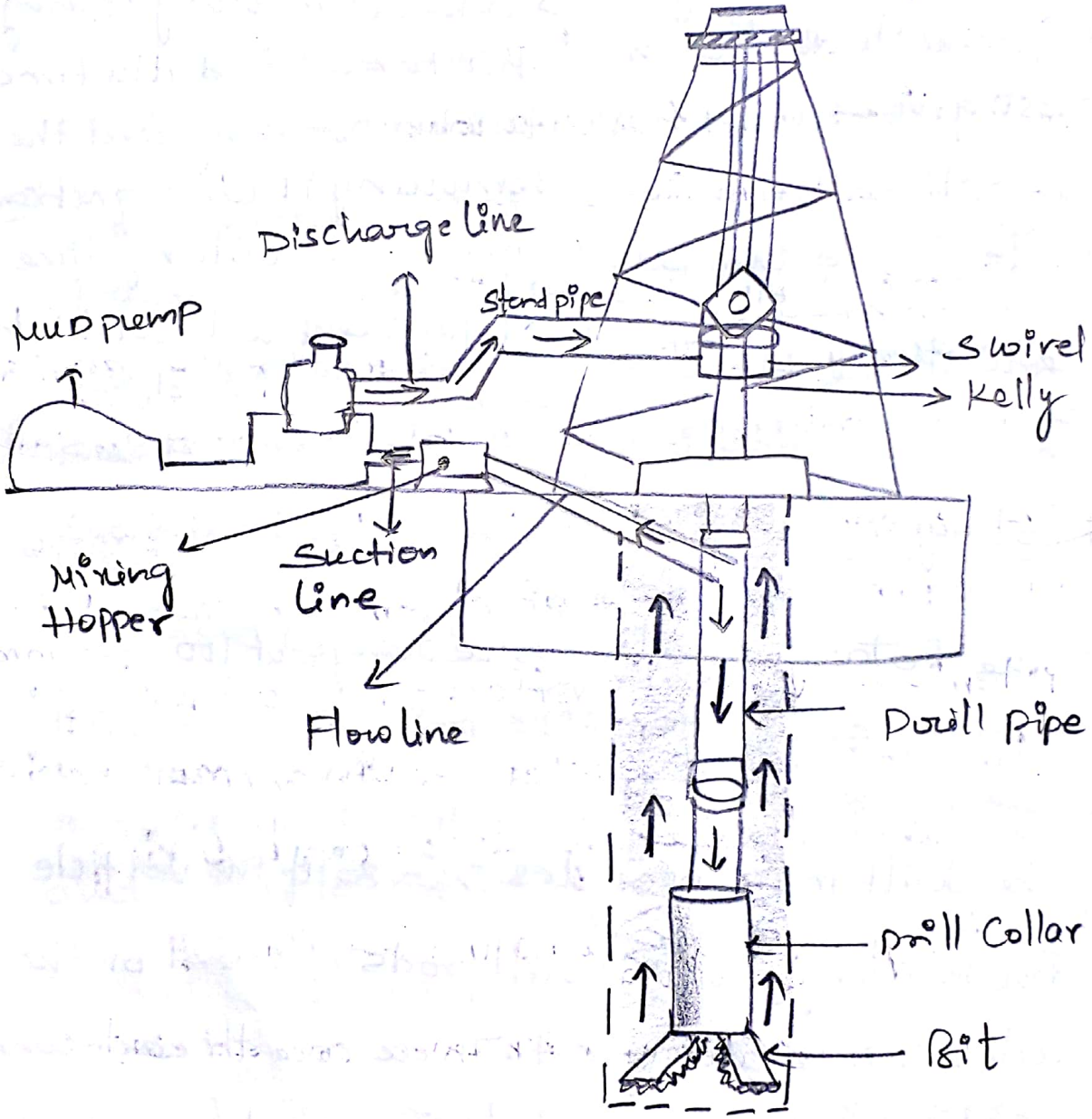
- It is generally suitable for unconsolidated formations such as Sand, stiff clay, sandstone and laterite, gravel layers
- Manual percussive Drilling depth up to 25m
- Equipment is very High, so Its better to Decide whether water logged or not, according to Selection will be finalized.

Advantages	Disadvantages
→ It can remove boulders and break harder formations, effectively and quickly through most types of earth	→ The equipment can be very heavy and relatively expensive
→ percussion drilling can in principle deal with most ground conditions	→ Especially in Harder rock the method is slow
→ Can drill further into water table than Dug wells, Even drilling past one water table to reach another.	→ when temporary casing has to be used, the time taken during and the removing it can significantly Increases drilling time
	→ Equipment costs are high and method is slow.

Rotary Drilling :

- The Rotary drilling site range of 100-445 mm Diameter, longer site being 200, 250, 311 and 381 Diameter.
- The drill may operates 25° - 30° of the Verticle
- For drilling, hollow drill rods of steel or the alluminium are used. These are thread-connected and transmit torque and feed pressure to the drilling bit or drilling tool which is attached at the End of column of drill rods.

- Rotation of the drill rods is through gearing driven by the prime mover at the surface
- At the end of rods rotate, the drilling tool abrades the rock and the cutting are cleared by pumping water under pressure or Compressed air down the hole through the hollow drill rods.



- The water or air, along with cuttings, Comes to the surface through space between the drill rods and sides of drill hole.

In some drillings, specially those for oil exploration, mud which is not very viscous, is circulated instead of water.

The mud which keeps back any water, gas or oil pressure encountered during drilling is known by the various trade names such as bentonite, aquagel ect. and these muds serve different in the mining areas it may be necessary to resort to mud flushing when passing through a fractured or friable tone.

Aluminium rods weight only halfs as much as steel rods, but owing to their bigger guage they possess 90% of the mechanical strength of the latter

The couplings, which are the parts most exposed to wear, are made of chromium - nickel steel.

Aluminium generally offers many advantages like capacity, Easier Handling, mor rapid and simple removal of the drill string

Rotary method subdivided into:

* Drilling by saw toothed cutter
* Drilling by tricone rock roller Bit
* Drilling by Diamond drill Bit
* Drilling by chilled shots.

Rotary and percussive drilling

→ Drilling by rotary percussion is the most classic system for drilling blast holes, and its chronological appearance coincides with the Industrial development of the Nineteenth Century. The first prototype machines made by Singer (1838) and Couch (1848) were run by the steam, but it was when Compressed air was used as the Source of energy, in the Execution of the tunnel of the mont cenis in 1861.

→ The drilling principle of these rigs is based upon the Impact of steel piece (Piston) that hits a utensil which transmits at the same time that Energy to be bottom of the blast hole by means of the final element called bit.

→ The Rotary percussive rigs are classified in to two major groups.

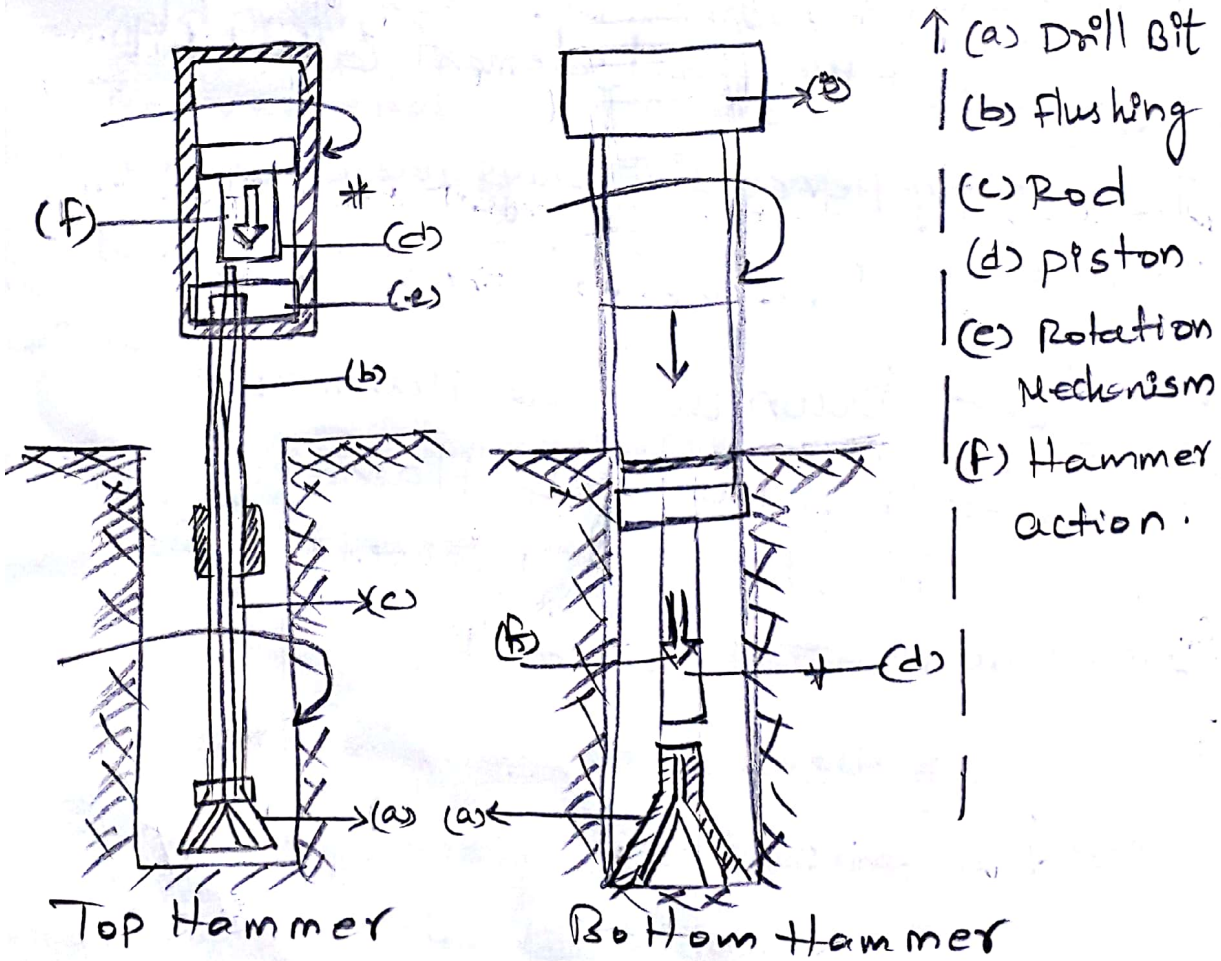
— Down the Hole Hammer
— Top the Hole Hammer

Down the hole hammer :-

The percussion is directly delivered to the drill bit. where as the rotation is performed outside the hole. Then the piston is driven pneumatically while the rotation can be Hydraulic or pneumatic.

Top the Hole Hammer :-

In these drills, two of basic actions, rotation and the percussion are produced outside the Blast hole, and are transmitted by the Shank adaptor and the drill steel to the Drill bit. The Hammers can be driven by the Hydraulically or pneumatically.



(a) Drill Bit
(b) flushing
(c) Rod
(d) piston
(e) Rotation Mechanism
(f) Hammer action.

→ By the illustration can find a simple difference between the top hammer and Bottom hammer - i the In the top Hammer, the percuerion action is at the top. The hammering actions takes place in the cylinder and it will rotate with the specific RPM.

→ In the Down hole hammer method, the Rotation mechanism totally will be in top and the cylinder which offers percuerion affect will be at Bottom above the Bit.

Some fundamentals related to Rotary percuerive

Percuerion : The impacts produced by the repeted blows of the piston, generate shock waves that are transmitted to the bit through drill steel. (top Hammer) or directly upon it (Bottom).

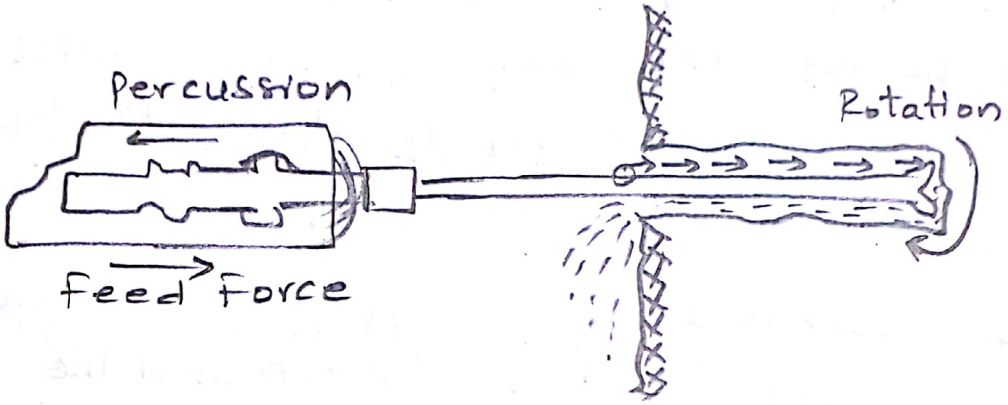
Rotation : With this movement the Bit is turned so that impacts are produced on the rock in different positions.

Feed or thrust load :

In order to maintain Contact with the Drill bit feed force will applied to the drill string.

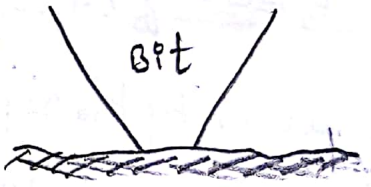
Flushing : After crushing of the rock, the peices will be flushed away by the Circulating fluid.

Basic action of the Rotary - percussive drilling :



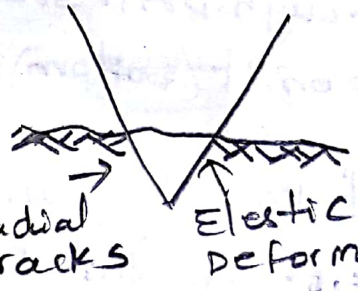
Sequence of rock failure during Cuttes formation:

(a)



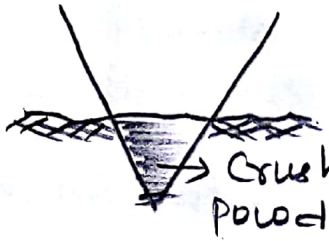
→ Crushing of rough edges of the rock upon Bit contact.

(b)



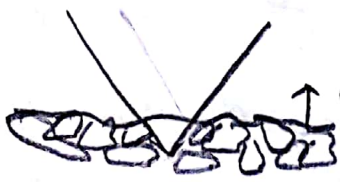
→ Radial cracks appears from the points of stress concentration and V shape wedge formed.

(c)



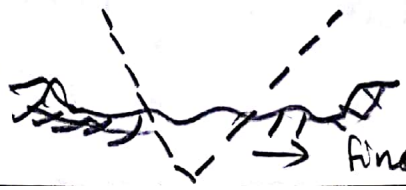
→ The Rock of the wedge is pulverized

(d)



→ The larger fragments are chipped in the zones of next to wedge

(e)



→ The drill cuttings will be flushed away.

- The most common speed of the bit is generally between 80 to 150 rpm, with the angle of the inclination between 10-20°.
- For the Button bits speed may lower to 40-60 rpm with the Dia of 51-89 mm along with the inclination of the 5 & 7°.
- The Blast hole flushing is carried out with a flow of air, water or foam that is injected by the pressure to the bottom through an the opening in the center of the drill steel and flushing Holes in the drill bits.
- Usually cutting will be removed space between drill rod and the Blast hole.
- Sometimes foam is allowed in Combination with the air to bring large particles of the Crushed rock to surface.
- The velocity of air flow to efficient cleaning with air goes 15-30 m/s.

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Selection of Drilling Equipments

following factors must be taken in to account :

- scale and Complexity of the project. The total amount of materials to be Excavated and the project schedule for the Excavation.
- Geological Conditions of project, Especially the rock Drillability.
- Environment Conditions. Including the Distance from the Residential area, Slopes and other Sensitive receivers (structures, Buildings) relative law and the regulations.
- Compatability with other Excavation Equipment, like loading and Hauling, for the Job. whatever the Equipment must be technically advanced but Compatible with Existing machines and also anything being purchased.
- Detailed calculations are necessary to determine which equipment is the most Economical then the Efficient, practical and technically suitable.
- Versatality : Generally drilling must done in Different conditions, It selection should fulfil.

Selection of Carrier :

- Three types of carriers are available
  - * Rail-mounted
  - * Crawler-mounted
  - * wheel-mounted

According to circumstances, required carrier will be selected.

Usually crawler-mounted and the wheel mounted opted more.

- Rail-mounted rarely used for the Jumbo in construction projects.
- Tyre-mounted generally used for Jumbo in mines.

Selection of Boom Coverage :

- Booms have a slightly different coverage when they are mounted on a drill rig.
- The Boom Coverage must be reach all the corners of the tunnel.
- Usually Drilling Jumbo can be Equipped with one to three booms, and Coverage 12 m^2 to the 230 m^2.

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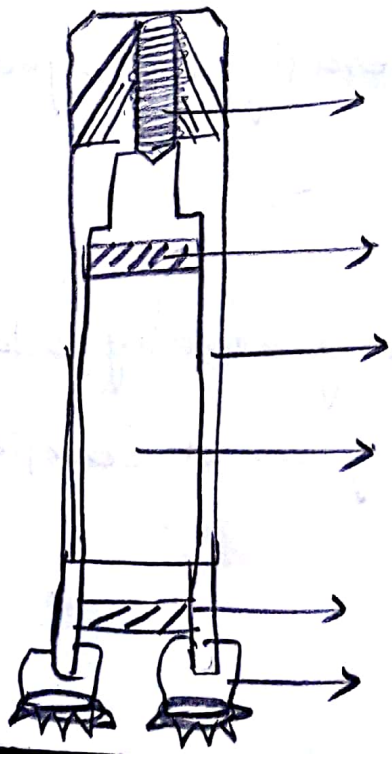
Core Recovery

To collect the core of the rock drilled, a device known as the core barrel is used. The length varies from 0.5 - 3m. There are two types.

- ✓ Single tube core barrel.
- ✓ Double tube core barrel.

Single tube :

- ✓ This is suitable for Homogenous formations where the core is not Eroded by the flushing water and Solid core can be taken without risk of Blockage in the Barrel.



- The Connection of the Diamond Crown to the Bit will be arranged at lower.
- The Core lifter is placed with in the bevel Shall which has its inside Conically Shaped to receive the former.
- The Core lifter is Corrugated on the inner face and the split ring.
- After Some progress in the drilling the rods are lifted to take out the Core, the split ring descends inside the bevel Shell and grips the Core.
- Generally the core replaced after the 2To m of the drilling.
- For getting out the large particles, water 900 liters/minute, generally Deployed to get proper Core.
- Single Core barrel is generally adopted where strata strong and Competent

Double Core Barrel :-

- In soft and friable rocks, the core is partially washed away due to circulating water flowing past it.
- The Rotation of the barrel greatly assists in grinding the core so that its relovery in a single tube core barrel operates poor.
- To avoid such difficulties a double core Barrel is used, specially where good core of soft rock is desired.
- In a double core Barrel inner tube with holds the does not rotate during drilling as it is suspended on Ball Bearings. mounted in the Block at the top of the Barrel permitting the inner core Barrel to remain stationary.
- Double Barrel Improves Efficiency which gearup Economy.
- In Hard rock, by low speed, High pressure core can be obtained in good manner.

Different types of the rock Drilling systems:

- → Mechanical : percussion, rotary & Rotary percussion
- → Thermal : Flame, plasma, Hot fluid, freezing
- → Hydraulic : Jet, erosion and Cavitation.
- → Sonic : High frequency vibration.
- → chemical : Micro Blast and Dissolution
- → Electrical : Electrical arc, Magnetic Induction
- → Seismic : Laser ray
- → Nuclear : fusion and fission.

Micro-Bit Drilling :

- It is applicable on Medical, Electrical and gold industry.
- The fixed machine is fixed and has very precise spindle capable of High speed rotation with low dynamic run out.
- The Diameter 0.05 mm – 2.5 mm.
- It generates small chips and less heat while cutting is performed on the chip.
- It is recomended to use mist oil / air for the chip Evacuation and Cooling.
- There are generally Cobalt steel or Micro grain tungsten Carbide.

Drill Bits :-

- > Insert Bits
- > Button Bits

} Rotary-percussive

Common features of the Both Bits :-

✓ The Rods are threaded to the end of the bit so the transmission of impact energy is as direct as possible to the rock.

✓ The Bits have a series of central and lateral openings through which flushing fluid is then injected and they have channels through which the rock particles produced pass upwards.

✓ The Bits are designed to be slightly conic, with the widest in contact with the rock so as to counteract the wear and avoid an the Excessive adaptation to the Blasthole well.

Types of Bits used along with Rotary-Percussive :-

- > Chisel Bit
- > Cross Bit
- > X Bit

} Insert Bits

→ Chisel Bit:

These are Commonly used for handheld rock Drill for the Hard rocks. one piece of the tungsten Carbide is fixed in the I-bit.

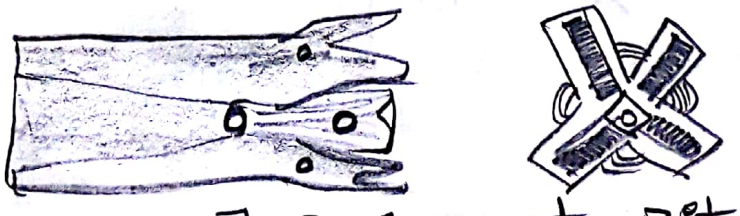
→ Cross Bit:

There Consists of four tungstene Carbides inserts at a 90° angle.

→ X Bit:

There are Consists four tungstane, Inserts at 75° and 105° angles between the insert pair.

- The Site of Insert can be varied according to the drill hole site, rock type and the abbrasiveness of the rock.
- Generally Insert bits are Diameter from 85 to 64 mm.
- Although insert bits may be less Expensive But shorter rendering intervals and the life Expectation, which often makes them less Economical than button Bits.



Insert Bit

Button Bits :

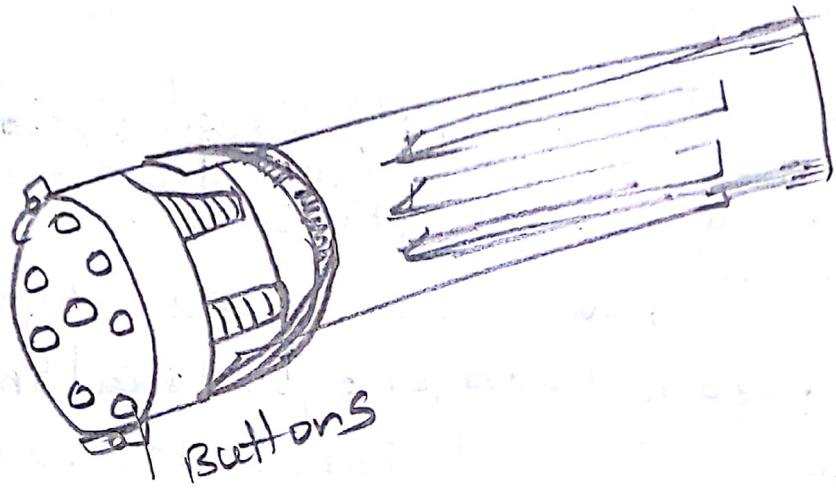
- These are most popular type of Bit in use today for big hole, High production and the Blast hole drilling.
- There bit have buttons or cylindrical inserts of tungsten carbide distributed in various patterns on the face. General Diameters are the 50 - 251 mm.

The Manufacturing should meet following needs :

> Allow for rock chips to clear and avoid recutting
> Hold gauge and retain cleaning flutes
> present the most effective Impact alignment of Carbides to break and chip the rock.
> Drill straight.

Generally :

- There are generally cylindrical bodies with a larger diameter on top and the stem - a spline shaped.
- The number of hard metal balls in the shaped of hemisphere are Sintered on the head and on side to flush cuttings from the



- There are Certain vertical Shots at the side to provide a passage for the cutting to come out of the holes.
- Rotational speed varies from 10-20rpm.
- The Bodies are made of alloy steel and the heat treated. The hole diameter 100-200m

Bits generally used in large opencast mines:-

> Drag Bit

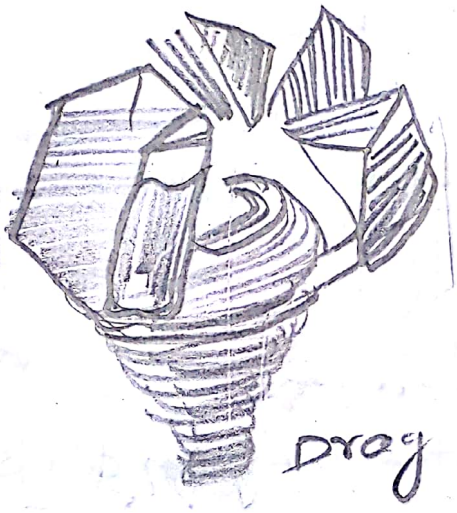
> Carbet Bit

> Tricone rock roll

> Diamond drill

Drag Bit :-

- They are three-four cutting wings tipped with Carbide insert and usually an A.P.I regular threaded pin Connection. Blade bits have a similar cutting action, Except that Blades ureplaced.



Drag Bit

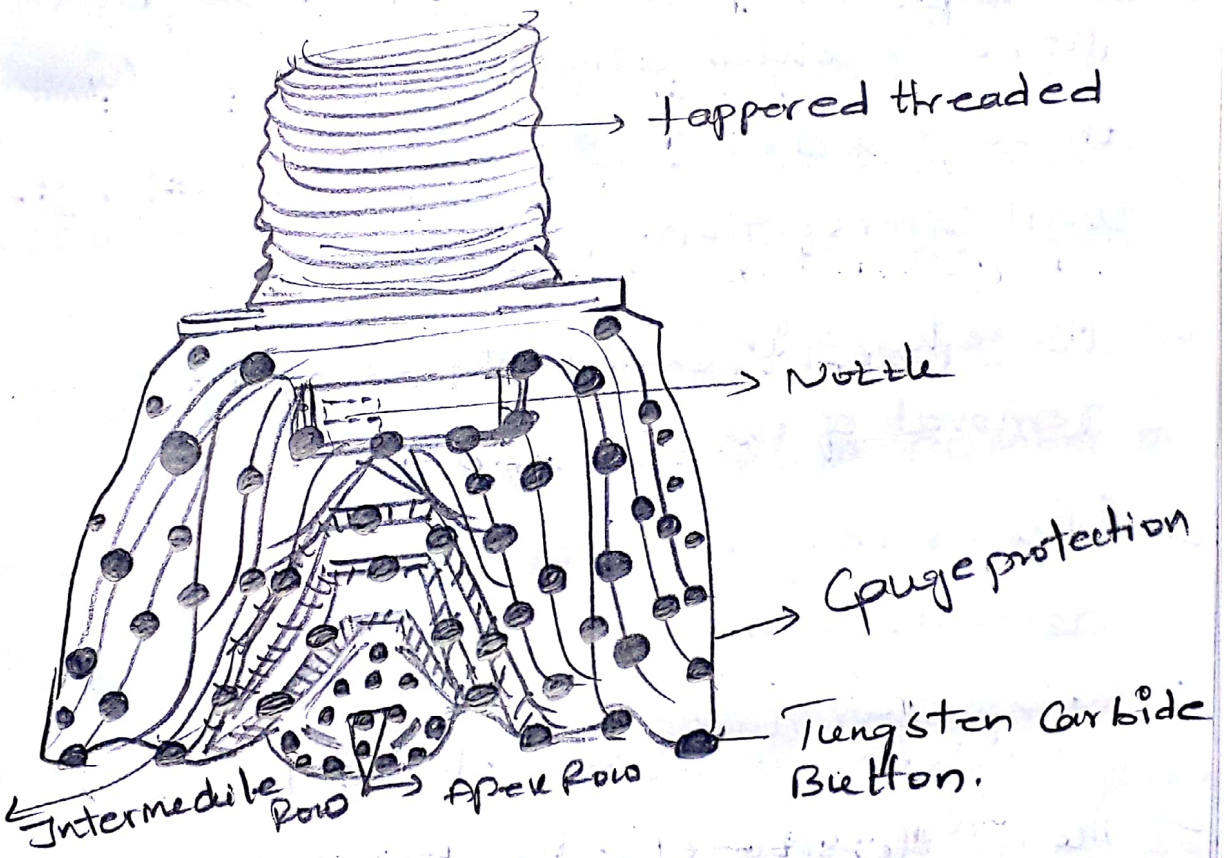
Corset Bit :-

- The drill Bit in this case is essentially a cross Bit tipped with the tungsten Carbide and it is an Integral part of unit called Corset Bit
- It has five air holes (one at center and four on the sides).
- The drill bit usually fitted in a 1.5m long pipe like device known as hammer. This hammer Contains a piston and valve arrang-ement.

- During operation, Compressed air passes down the hollow drill rods through flipper valves and exerts pressure on the piston, which turns strikes the bit.
- Air then Enters the bottom of the piston through a passage away around the cylinder when it is at the Ends of its down stroke, and lifts the piston up.
- In the piston the passage way is cleared and the Entrapped air below is released through the Cutter bit is there by cleared again.
- The piston is then struck by an air stream at its top and this forces it down and thus the process of up and down movement of the piston gets going.
- Generally pneumatically operated drilling machines, the piston strikes the Cutter bit about 1000 times/min at full pressure.
- These bits have Line Contact with the rock and Constant impact while breaking and atomizing wears out the Contacts.

Tricone Rock Roller Bit :

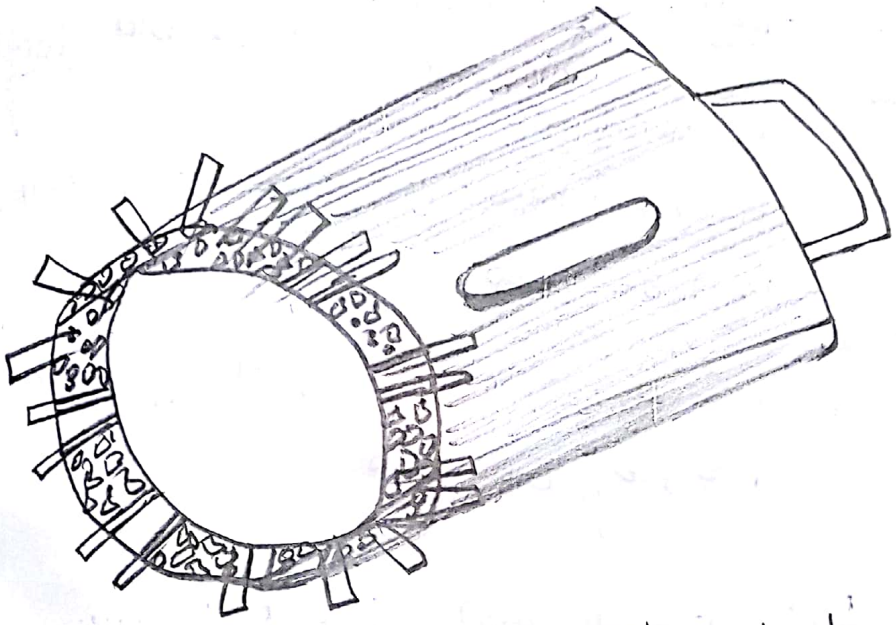
- In a Rotary drilling machine, which are the Electrically driven in Combination with the pneumatic and hydraulic systems, the drilling tool is a tricone rotary bit
- There Consists of three truncated Cones are placed 120° to Each other.



- The surface of the there truncated Cones have number of cutting teeth they are mounted on two bearings, one a roller bearing and the other a ball bearing.

- Roller bearings are positioned to support the radial load and free of thrust loads acting longitudinally along the bearing pin.
- Bearing pins in rock bit heads are forged integrally with each section of the bit body.
- The teeth of the cones are hard faced to give resistance to abrasive wear.
- The bits are fitted with three air blast nozzels which direct the air blast coming through a drill pipe to the bottom of the wall Intersection.
- These helps in Quicker and more Efficient removal of the cuttings
- The size of the nozzle required in the bit depends on the volumetric output of the Compressor and its operation pressure capality.
- The Nozzle size should be such that it only clears but also cools the Equipment.
- Rotary speeds from 60-1200rpm and for a toothed bit 50-80 rpm tungsten carbide bits.

Diamond Bit :



- This method is commonly adopted where cores of rock passed through are desired for the accurate records of strata or for testing the rocks for their strength, composition, porosity
- The Drill bit consists of cylindrical cast steel shell having in its lower face a number of small sockets in which pieces of Black Diamonds are placed.
- The diamonds are artificial, not useful for the jewellery, But drill bits for their hardness and the bit is suitable for the hardest rocks.
- The drill rod and drill bits are specified under two main groups, X & L series.

— The Hole sizes are designated as NX, BX & AX, EX

standards	Drill rod outside		Hole dia	Core dia
	X series in inch	K series in mm		
NX	2-3/8	NW-67	75	54
BX	1.29/32	BW-54	60	40
AX	1.5/8	AW-44	47	28
EX	1.5/16	EW-35	38	21

Factors affecting drill Bit :-

The mean which influences the drill Bit are Hardness, structure, compressive strength and abrasivity.

Hardness :-
- Hard Rocks
- Cohesive rocks
- Friable rocks
- Flow rocks

Compressive strength :-

→ It mainly depends on wheathering ranges from 500-5000 kg/sq.cm and also the mineral photographic characteristics.

Drillability :

Abrasiveness :

Rock Drillability :

→ It is defined as the penetration of the drill bit in to the rock Expressed in meters/minute.

→ Drillibility is the resistance of rock to penetration by the drilling technique, and it is term used to describe the influence of numbers of parameters on drilling rate and the tools wear of the drilling machine

→ penetration of rock is influenced by the rock properties as well machine parameters.

→ The factors affecting Drillability :

- Hardness
- Toughness
- abrasiveness
- Compressive strength
- tensile strength
- Drilling tools
- Thrust
- R.P.M
- type of Drilling (wet or dry)

Comprehend(1st Unit)

Topic name:

Date:

What you understand from the topic:

Rate yourself (10):

Rapid test

Comprehensive Scrutinizes

- Scrutinize Area:

- Define Problem?

- Root Cause:

- Control Measures:

- Your Perception:

- Any Enhancements:

PPT Talks

- Topic:
- Subtopic:
- Extracted Core Stuff:
- Pen the Illustrations:
- Mathematical terms:
- What you understand?
- Rate your friend(10):

Journal Interpretations

- Journal name:
- Title:
- Authors names:
- Publishing year:
- Synoptic abstract

- Pen the Illustrations:

- Gross theme:

- What you understand?

Journal Interpretations

PASTE JOURNALS HERE

9/11/2016

MODULE — II

Explosives

*Historical Development of Explosives:-

→ Explosives is a solid or liquid or mixture of substance that contains a large amount of potential energy which on the application of suitable stimulus (heat, Impact, friction, electricity, shock (Detonation) to the small portion of the mass is Converted and Expands in to largely or Entirely gaseous, Due to Development of the heat and High pressure in very short span.

→ At its root, The History of chemical Explosives lies in the gunpowder, It is a first type of physical Explosive. During the Tang Dynasty in the 9th Century, Taoist Chinese alchemists were Eagerly toying to find the Elixir of immortality, It the process they stumbled and Invented Explosives like gunpowder. made from Coal, saltpeter and Sulfur.

→ Gunpowder was the first form of the chemical Explosives by 1161.

→ The chinese would incorporate Explosives fired from bamboo or bronte tubes known as bamboo fire crackers. The chinese also used inserted rats from inside the bamboo fire crackers to fire towards their Enemy, creating great psychological scaring to enemy's.

→ Later, china in 9th Century they started using Black powder, This material was sensitive to water and produces dark smoke

→ Later stronger Explosive used in 1847 was Nitroglycerin and ~~trinitro~~ toluene in 1863 and Dynamite, gelignite in the year of 1867.

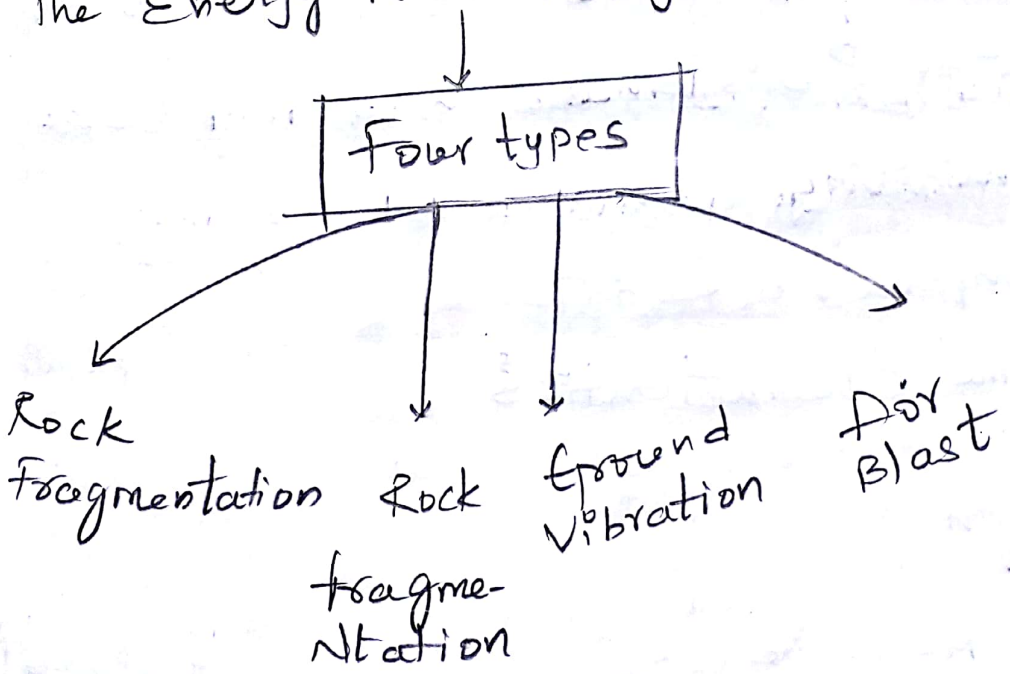
→ World war-II is adopted better advanced Explosive than war-I like PETN & TNT.

→ Continued Research has produced many types like percholates, chlorates, ammonium nitrate-fuel oil mixture and liquid oxygen Explosives etc..

A Commercial Explosive Contains following mixture

- ✓ Combustible matter such as wood meal fibre, sulphur and charcoal etc.
- ✓ Oxidation agents such as Sodium Nitrate Ammonium Nitrate and potassium Nitrate ectc.
- ✓ stabilizers such as Magnesium & Calcium Carbonates.
- ✓ Anti-setting agents to prevent caking of salt
- ✓ Sensitizers like Metallic powders.

The Energy Released by the Explosive produces



* The main theory is Detonation of the Explosive charge Cause a high-velocity shock wave and a tremendous release of gas

In Simple :

The shock wave cracks and crushes the rock near the Explosives and creates thousands of cracks in the Rock.

*

Properties of Explosives :

- Strength
  - Absolute weight strength
  - Absolute Bulk strength
  - Relative weight strength
  - Relative Bulk strength
- Density
- Velocity of Detonation
- Detonation pressure
- water Resistance
- Sensitivity
- Temperature Resistance
- Fume characteristics

Strength :

It is a Measure of the ability of an Explosive to to useful work and refers amount of the Energy stored in the Explosive.

Strength is generally expressed in following.

Absolute weight strength (AWS):

It measures absolute amount of energy in calories available in a unit mass of explosive, It is generally quated in kcal/kg

Ex: ANFO – 930 kcal/kg

Absolute Bulk strength (ABS):

It measures absolute amount of energy in a unit volume of a explosive, kcal/m^3

$$ABS_{Exp} = AWS_{Exp} \times P_{Exp}$$

Relative weight Strength (RWS):

It is a weight Comparision between equal weight explosives.

$$RWS_{Exp} = (AWS_{Exp} / AWS_{ANFO}) \times 100\%$$

Relative Bulk Strength (RBS):

It also measure the Energy available in a given volume of explosive Compared to an equal volume of Bulk ANFO.

$$RBS_{Exp} = (ABS_{Exp} / ABS_{ANFO}) \times 100\%$$

Density :-

Generally defined as a Mass per unit volume Expressed in g/cc.

→ The prime purpose of varying the Density of an Explosive is to Enable the total energy charge in a blast hole to meet the particular field Conditions.

If Hard Massive rocks :-

Here moto is to ultimately to Break, so Denser Explosive are required.

If Watery Holes :-

If the Density of Explosive is less than water, Explosive will float. So In watery Holes High Density Explosive must be used. Generally Explosives vary 0.8 – 1.35 g/cc.

Wate Resistance :-

→ In Some Cases, their meet need to charge Blast hole Explosive in watery hole.

→ So It is Important to know which Can Resistant to water and which are not.

→ It wet Conditions gelatinous or slurry Explosives must be used. NG based also good.

Sensitivity :

→ An Explosive Sensitivity is the amount of the Energy needed to Cause a reliable initiation of the Explosive.

→ It is also called Min Booster Rating
Min priming Requirement

→ Generally Sensitivity affected by wate and inadequate charge and Extreme temp Con. -ditions.

* Velocity of Detonation :

→ It is the Rate of Detonation, wave passes through a Column of Explosive and this is of Considerable importance as the shock energy of Detonation increases rapidly with this velocity.

→ Most of High explosives used in the Mines have velocity of Detonation b/w 2500-5000

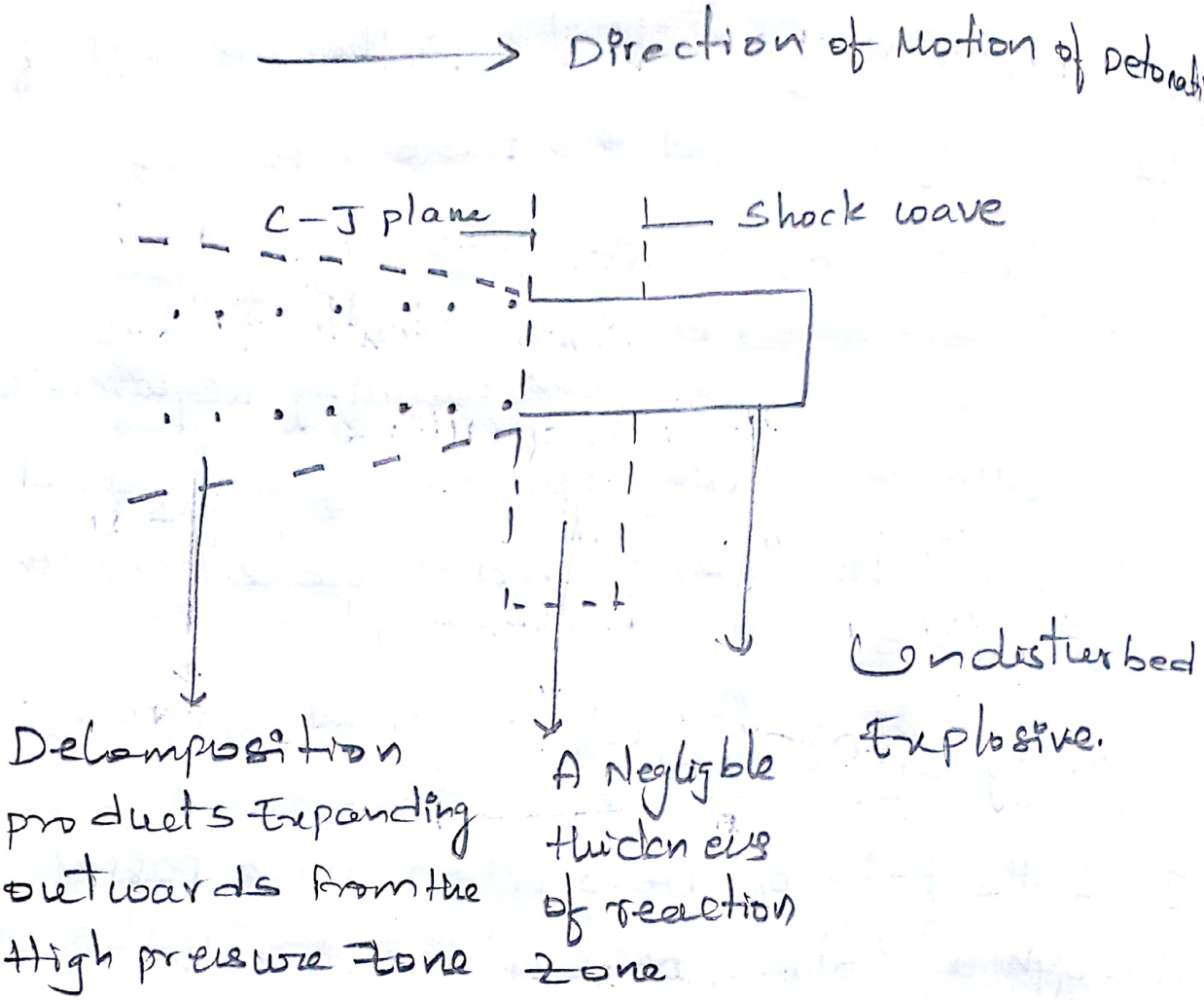
* Detonation pressure :

→ It is a pressured derived from the shock wave moving through Explosive Column

→ It is the pressure in Reaction Zone behin the Detonation Zone, at the C-J plane

→ Expressed in Kilobar.

What is C-J plane:



→ A space in a Explosive between Reacted and un Reacted planes was Explaine by the Chapman & Jouguet That is called C-J plane.

In simple

Explosive Reacted / space is called C-J plane / Explosive Un Reacted

Temperature Resistance :

→ All Explosive Cannot stored under Extremely Hot or Cold conditions

→ In Hot storage conditions, beyond 90°F many compounds may slowly decompose and change their properities

→ Similarly storage of Ammonium nitrate at above 90°F, Results poor.

→ Slurry explosive will face serious problems if stored in cold temperature.

fume characteristics :

→ It measures amount of toxic gases produced in the detonation process.

→ Carbon monoxide and nitrogen oxides are the most common gases that are considered in the fume class Rating

→ Commercial explosives are oxygen balanced to minimize fumes. However, fumes can still occur as a Result of Blast Environment Conditions such as insufficient charge.

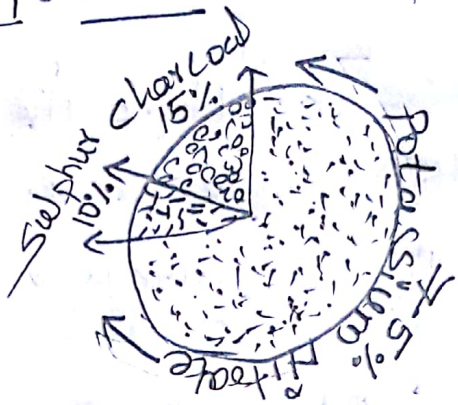
Types of Explosives

- **Low Explosive** — It Deflagrates
  - They Burn, Although very Rapidly
  - ✓ Black powder
  - ✓ Smokless powder
  - ✓ Flash powder
- **High Explosive** — It Detonates.
  - This change to Molecular Structure and happens instantly Rather Burning
  - **Primary Explosives**
    - ✓ Lead Azide
    - ✓ Lead Styphainte
    - ✓ Mercury Fulminate
    - ✓ DDNP
    - ✓ Tetrazene
  - **Secondary Explosives**
    - **Boosters**
      - ✓ PETN
      - ✓ RDX
    - **Main charge**
      - ✓ Dynamite
      - ✓ Binary
      - ✓ water gel
      - ✓ Emulsion
      - ✓ TNT
      - ✓ ANFO
      - ✓ Slurry

Low Explosive Vs High Explosive

Low Explosive	High Explosive
> When a low explosive is blasted the process of oxidation of the constituents substance is propagated by the rapid Combustion from particles through the mass of Explosive there Explosion is also Relatively very low.	> Here the High Explosive Explodes when a violent shock is applied to it with the help of detonator, the process of oxidation does not particle – particle But instantenous with High velocity
Ex: Gunpowder	
> These type are fired by the Ignition or flame	> These Contains an Ingredients which Explosive itself.
> These are very low in velocity of detonation.	> There produce Shattering Effect
* Gun powder	* Nitroglycerine * Ammonium Nitrate * Tri-Nitro-tolune * Booster * ANFO * Slurry Explosive * Emulsion * Heavey ANFO

Gunpowder



It is a pure mixture of
- > 75% of potassium Nitrate
- > 15% of charcoal
- > 10% of sulphur

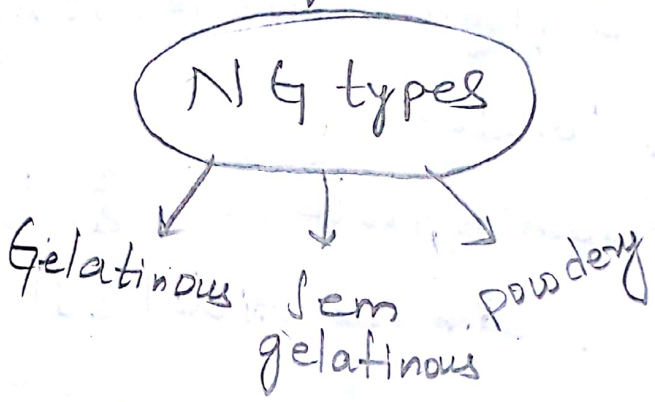
- It is stable, cheap and safe to Handle
- It Dont possess any heating affect in u/g mine
- Can Easily manufacture and available
- Can't use for large/extent areas.
- It is fired by the safety fuse.
- Not suitable for wet conditions.
- In this potassium Nitrate produces oxygen and charcoal produces fuel.
- Gunpowder produces about 500 times its own volume when Converted into gas.

$$KNO_3 + C + S = K_2CO_3 + K_2S_3 + CO_2 + CO + N_2 + \text{Heat}$$

- The all ingredients being finely ground and Intimately mixed.
- The Grounding is generally being done by the Copper or bronze non-sparking material.

Nitroglycerine:

- It is a oily fluid with specific gravity 1.6
- freezing point at 13°C. And it can soluble in water. Very sensitive for shock wave



- It produces High shattering effect
- Can Causes headache with fumes in long exp
- NG based will liable to more sensitive to detonation, when it freezes more, usually when temperature falls at 8° or less
- To avoid such situations, some times NG like explosive Di-Nitro-glycoal with low freezing agent will be in use
- Generally low freezing Agents are marked with "polar"

Ex: > polar viking
> polar Special
geletine....

> It is more suitable for Industrial use.

Ammonium Nitrate (NH_4NO_3):

- It is a white Hygroscopic salt, soluble in water
- Very safe to handle.
- Though it is a High explosive, It needs Booster to detonate.
- To use Ammonium Nitrate as a Explosive, It should mix-up with the diesel oil or NG / TNT.
- Here the intresting thing is, It can act as a oxidising agent and also Coolant.
- It doesn't occur Naturally, prepared by the Reacting by ammonia gas with nitric acid.
- $2NHHNO_3 = 4H_2O + O_2 + 2N_2 + 3646$ kcal/gm

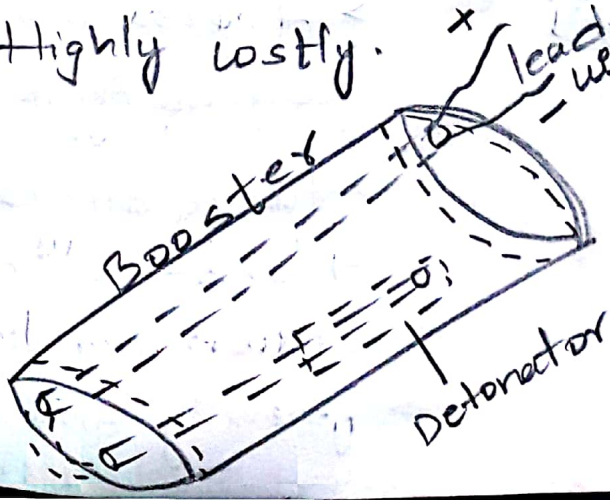
Tri - Nitro - toluene (TNT) :

- The Reaction between nitric acid and benzene forms TNT.
- The chemical formula is $C_7H_5N_3O_6$
- It is a crystalline and very toxic
- TNT is produced in three step process
- first toluene is nitrated with the mixture of Nitric and sulfuric acid.

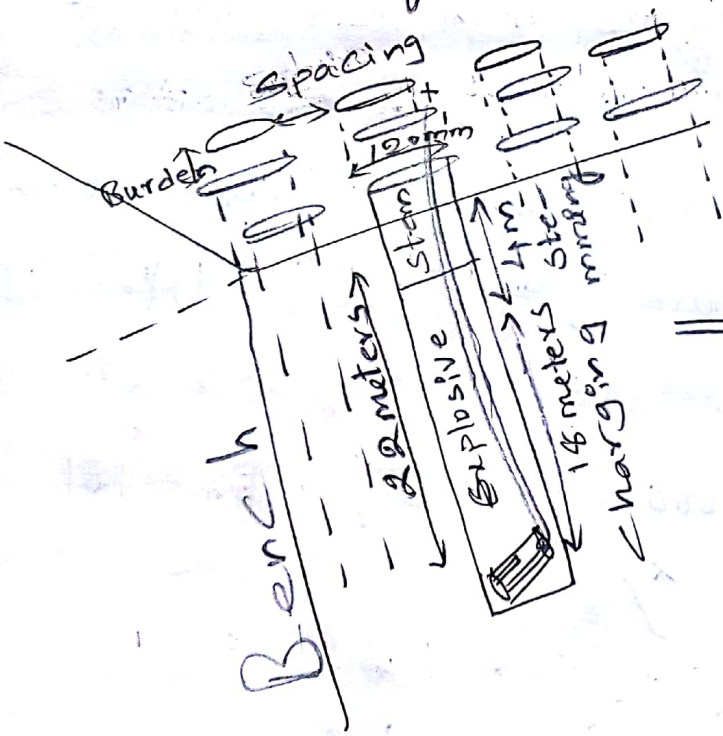
to produce mono-nitro-toulene (MNT). The MNT is seperated and the Re-nitrated to di-nitro-toulene (DNT). The final step is DNT is Re-nitrated tri-Nitro-toluene.

Booster :

- Generally Cap-sensitive Explosives are intiated with help of Detonator
- Non-Cap sensitive Explosives are intiated with the Booster.
- Genually Non-Cap sensitive are used in the open-cast mines
- Booster will helps rapid intiation for the large extents.
- Booster manufactures with the trade name of 'Primex', mixture of TNT and PETN.
- It is water resistant
- It's VOD is 7000 m/sec, S.g - 1.55 - 1.61
- Highly costly.



- Generally primer is cast in cylindrical pellets provided with two longitudinal holes for threading on to a down line of detonating fuse.
- for priming, a detonating fuse is threaded through the two holes in the primer pellet and a knot tied at the top. This assembly is then inserted in to a Cartridge of slurry and its mouth re-tied by a wire.
- After that freely dropped down the hole.
- Later AN-based site mixed or plant mixed slurry is used to pour in hole.



> The length of hole taken 22 meters

⟹ > Around 18 meters has charged with the explosive

> 4 meters Stemmed with the Aggregates

> two lead wires + and − will be drawn and joined

> generally AN & NG Based Explosives used

ANFO

- It is a Combination of the ammonium nitrate and diesel oil. Most effective oxygen Balance Explosive will be materialised by adding 5-6 % of the Diesl oil.
- Generally used in large scale Blastings
- It VOD is 3500m/se, Sp.g - 0.8-1.0, Lot Strength-80
- Generally in dry season for mixing 100kg's of Ammonium nitrate, It Requires 7 Liters of Diesel oil; For wet season It may 9 Liters
- Some times Higher percentage Diesel oil will Reduces Sensitivity of the explosive.
- The mixture may feel irriation to the skin so Its better to wear rubber hand gloves and gum boots.
- The mixing should be done with wooden Shovels avoiding contact with Iron.
- ANFO will be Easy to Handle in Bulky loose rather than Cartridges
- Generally mechanical loader will use to mix the mixture.

- Electric Detonator should not used unless preventive measures used.
- As known, ANFo generally intiated with help of Booster.
- If ANFo is using in water Holes, It should be suitably packed in polythene bags.
- Generally above 62mm dia is generally used with ANFO.
- If increases beyond 300mm, Sensitivity will decreases, above 4% water also reduces VOD and above 9% will totally Damage the Explosive.
- Uniform mixing is Mandatory.
- In December 1956 - Melvin Cooks Invented Ammonium nitrate fuel oil.
- The safety and Efficiency of this Explosive is apparent and use of water was the revolutionary.

Slurry Explosive :

- It is mixture of
  - * Oxidisers
  - * fuel Sensitisers
  - * Cross linkage Agents
  - * gelly gums

Above all will be mixtured in aqueous medium thoroughly.

- It is a Jelly like Consistency and water gels
- For Better safety. In permitted Explosives coolant will also be used for the Reduction of Incendiety.
- It was also Invented by Dr. melvile Cook in 1957.
- The Major Components to form Explosive are

TNT : AN : WATER

20% : 65% : 15%

- The above remaining mixtures will be Later added to get, stabilize the Homogenous. Ex: oxidisers, Cross agents

- Some times using metallic powder along with the ingredients will gearups strength.

The Ingredients are

- **Oxidisers**
  - Ammonium
  - Sodium or Calcium Nitrate
- **Gelling agents**
  - Starch
- **Fuel Sensitisers**
  - TNT
  - PETN
  - Pentolite
  - } Explosive
  - Aluminum, Sugar
  - Urea, Paraffins
  - Hexamine, glycol
  - Ethylene, woodpulp
  - } All for the Non-Explosives
- **Cross linkage agents**
  - potassium or sodium dichromates
  - Antimony or Boron

- The sp-g will be more than one
- There also available in Bulk & Cartridges
- Few Slurrys only used in underground mins those will fall under permitted Explosives and should be Cap-Sensitive approved by DGMS
- There are Highly water resistant
- It would be Economical to use hole dia more than 62 mm.

- Slurry explosive will not explode accidentally if dropped, Even Involved in fire
- They have low toxic (non) fumes which don't causes headache.

Emulsion Explosives :

- It is a mixture of two liquids, But not mix Each other.
- This Emulsion is the two-phase system in which in inner or dispersed phase is distributed in an outer or Continous phase.
- Emulsions genrally used non-other than mining as insecticides, photographic films and paper, cosmetics.
- Here both oxidisers and fuels in liquid State
- Emulsion Explosives are in minute of the nitrate solution drop lets and their Compaction with in the Continous fuel phase
- As simple in total Explosive, the main oxidiser is Ammonium nitrate, which presents as droplets and Compacted

- At High temperature of the AN, Diesel oil will be added and Emulsifier will be added in a fast moving blender.
- The blender (like a grounder) mixes will all types of the ingreadients and finally forms grease like a Consistency.
- The final Resultant will be Emulsion slurry made up of droplets of AN, Sourrounded by fuel oil and artificial Air bubbles.
- The Air bubbles helps to Detonate more
- The VOD will be 5.0-6.0 Km/sec
- There are highly water resistant
- There are more fluid than slurry, so some problems may created while loading in the fissures or Crack Blast hole
- High Density, low cost

Heavy ANFO:

- It developed in 1980's
- The main moto is to enable water Resistant and increase density, Emulsion now mixing with the AN.
- The Ratio will be 20:80 – 50:50, Depending on the watery conditions
- Thus the mixture can have bulk density from 1.10 to 1.25 gm/cc
- Bulk strength almost 45% more than normal ANFO.

Permitted Explosives:

- All explosives create heat and some flame when fired, so to avoid such explosions of gas or coal dust in underground coal-mines It is essential that the whatever heat/flame producing should not cause or incapable of igniting which leads to explosion.
- For these reasons, DGMS & CMPS allows only few explosives after few authentic tests, those are calling as "permitted Explosives"

Conditions requiring use of Permitted Explosives

- As per CMR 2017, 198, Except in the stone-drift (without dry coal dust) and shaft working. Any where must and should use permitted Explosive.
- In gassy 2 & 3 only permitted sheathed Explosives used. In gassy 1 only permitted Explosives can be used
- If chief Inspector permits in gassy 1 non-permitted Explosives can also used
- If any stone drift or sheaft which is in five meters to the coal Seam/Reserves, In such conditions should use only permitted Explosives.

Precautions in the use of permitted Explosives

- As per CMR 2017, 199 No detonator should unless type approved by the chief Inspector
- where more than one shots are charged for firing, should be fired simultaneously.

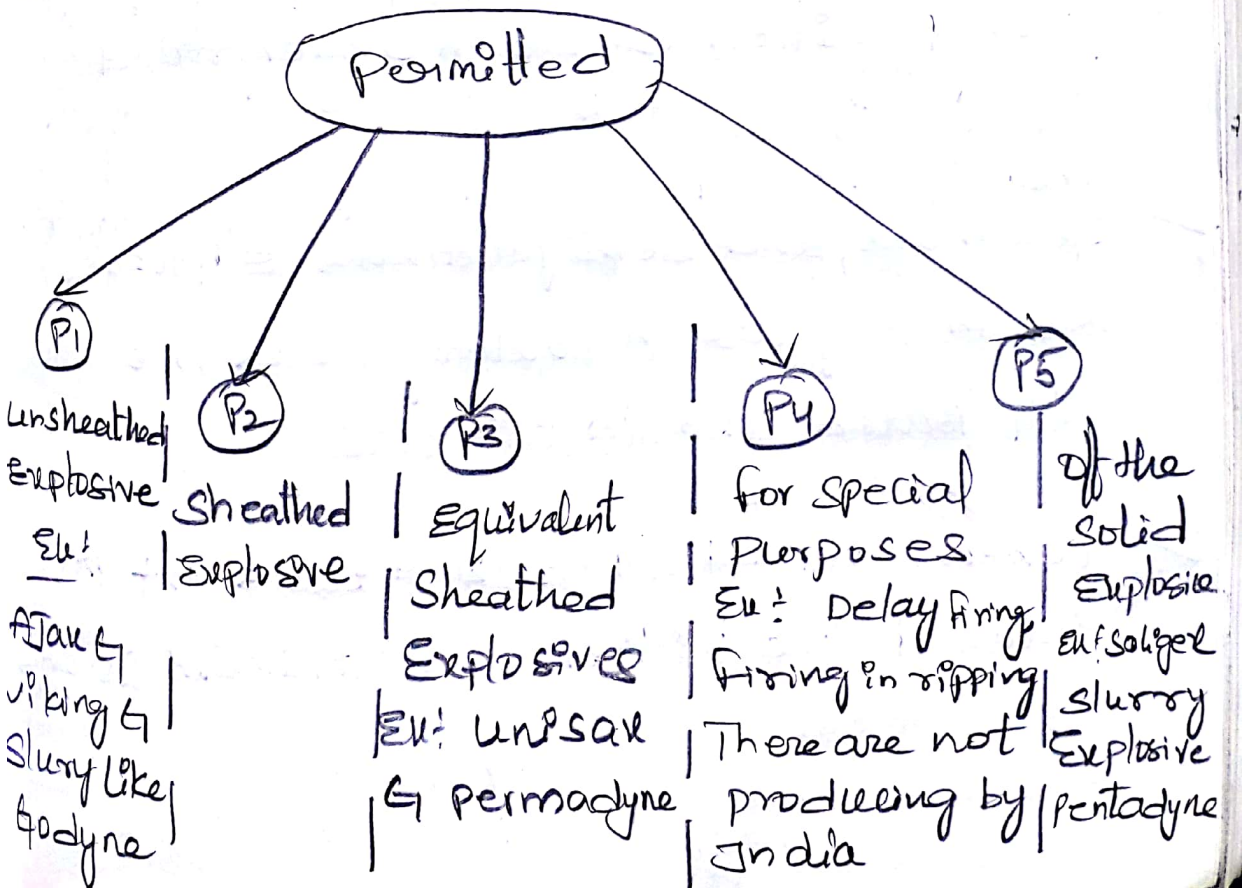
As per DGMS :-

The explosives will be subjected to the stringent test and if it found that incapable of the igniting the gas or coal dust then it will be tagged as "permitted (P) Explosives". Can be used in underground mines

The safety of the permitted explosives depends on mainly

* low temperature
* Duration of flame produced
* Kind of cooling Agents

Categorise of permitted Explosives :-



- P2 & P4 are not manufacturing in India
- The Cartridge of sheathed explosive coated with the $NaHCO_3$, In Blasting the $NaHCO_3$ Decomposes and form as a blanket of the CO_2 & H_2O round of Explosive, which Rendered more safe.
- Equivalent Sheathed is the Combination of the Ammonium chloride and Soda nitrate which provides more Safety.
- only Cap-Sensitive permitted Explosives should use in underground mines
- Non-permitted Can use in underground Metal Mines.
- Gelatinous and Semigelatinous Explosives should only use in watery Holes, No NH_4 Based should not use
- Where, Ever Hard rock exists, there should use higher VOD minimum 2500m/s

Testing of Explosive

The method provides a scheme of testing to determine whether a solid or a pasty substance presents a danger of the explosion when submitted to the effect of the flame (thermal sensitivity) or to the shock or the friction submitted to the effect of flame.

The standard safety test are

* Burning test
* Friction and Impact test
* Impact sensitivity by the Hammer fall test
* Rifle Bullet test
* Sensitivity of flame head test.

General description of all tests :

Safety-in-Handling test :

Impact sensitivity by Hammer test :

- By dropping a known mass from a known height, a quantity of explosive kept in between the surface of two stainless steel Hoffmann rollers of 6mm diameter.

- The observation is taken for maximum height and minimum height for ten times so as to observe the detonation or decomposition. This method is applicable to all the Explosives.

Friction Impact Sensitivity Test (Torpedo) :

- The test is for measuring the Sensitiveness of the Explosive to friction and Impact.
- A Torpedo shaped striker of known mass (1/4 kg. 1/2 kg) made of mild steel is allowed to slide down an inclined at a selected angle, on to a sample of Explosive mounted on a milled steel anvil.

Abel Heat Test :

- It is applicable to any Explosive which forms oxides of nitrogen on decomposition.
- When the test samples heated, oxides of nitrogen are liberated more or less rapidly according to stability of material.

✓ Traces of oxides of nitrogen are then detected by means of brownish line produced on starch-potassium iodide paper.

✓ This is done by heating of the explosive sample, oxides of nitrogen are liberated more or less rapidly in accordance with the stability of the composition.

✓ This test gives a comparative indicator of the stability of the explosive test samples.

Freezing and thawing test :-

✓ This is applicable only on NG based explosives

✓ Samples of 100 gm unwrapped cartridge is taken in a test tube closed with a velvet cork and kept at temperature of -3 to -6 degrees for 16 Hours, followed by the 8 Hours at room temperature.

✓ The test is repeated for 3 days and examined for any abnormality in respect of gel breaking / oozing out of NG.

Substitutes of Explosives :-

- # Airdox
- # Cardox
- # Hydrox

- There all consists of strong metal tubes, containing at one end a bursting Disc and venting strength.
- Inside the tube is a cartridge which causes to liberate high pressure gas at low temperature when pressure reaches the designed value the bursting Disc breaks and gas is then liberated violently from nozzles at end
- The sudden liberation of gas causes Breaking of the coal perfectly.
- The principle action of the Hydrox is Based on the chemical reaction of the Powdered charge, which forms itself the significant quantity of the inert gas (60-70% water vapours, Carbon dioxide, nitrogen Created at pressure of the 180 MP.

✓ The principle action of the Airdox is breaking by the compressed pressure, which causes by the instantaneous release of the compressed air from the pneumatic cartridge. (Sompa)

✓ The principle action of the Cardox is the based on the instantaneous transformation of the liquid carbon dioxide in steel cartridge after heating up to 400-500 mp, the gasses themselves Breach and Blasting will takesplace.

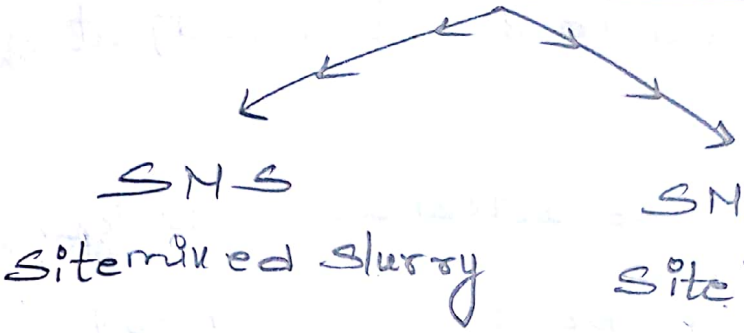
Bulk Explosive Systems

→ The combinations are the following.

* Dry Blasting Agents
* Site mixed slurry
* plant mixed slurry
* Emulsion systems
* Re-premble Emulsions
* Heavy ANFO

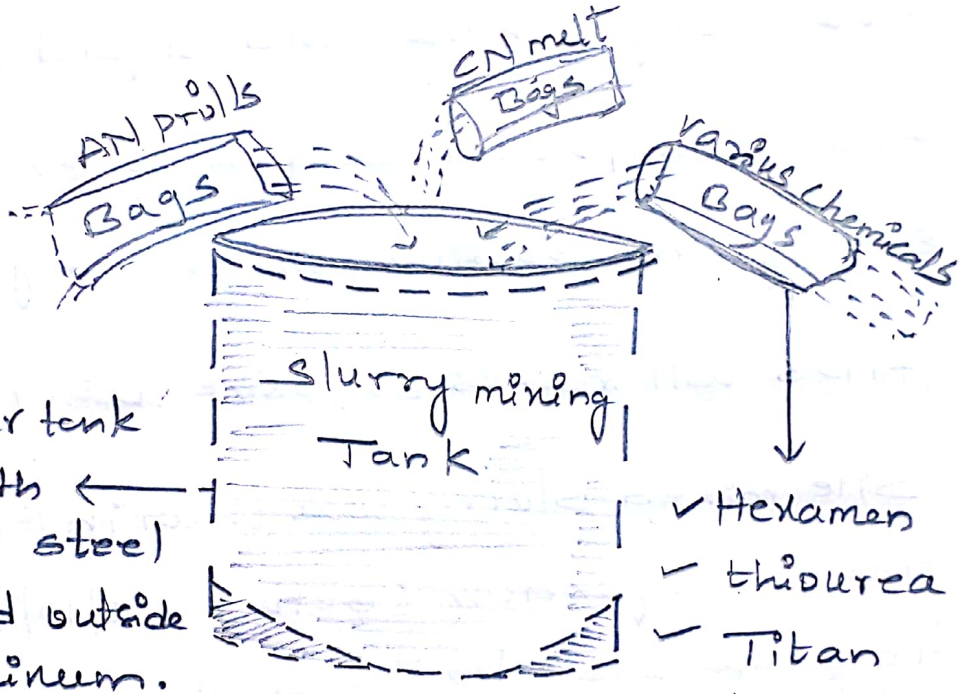
10/12/16

Bulk Emulsion



Site mixed slurry (Reference RG-OC1 & 2)

Rough layout of the SMS plant :-



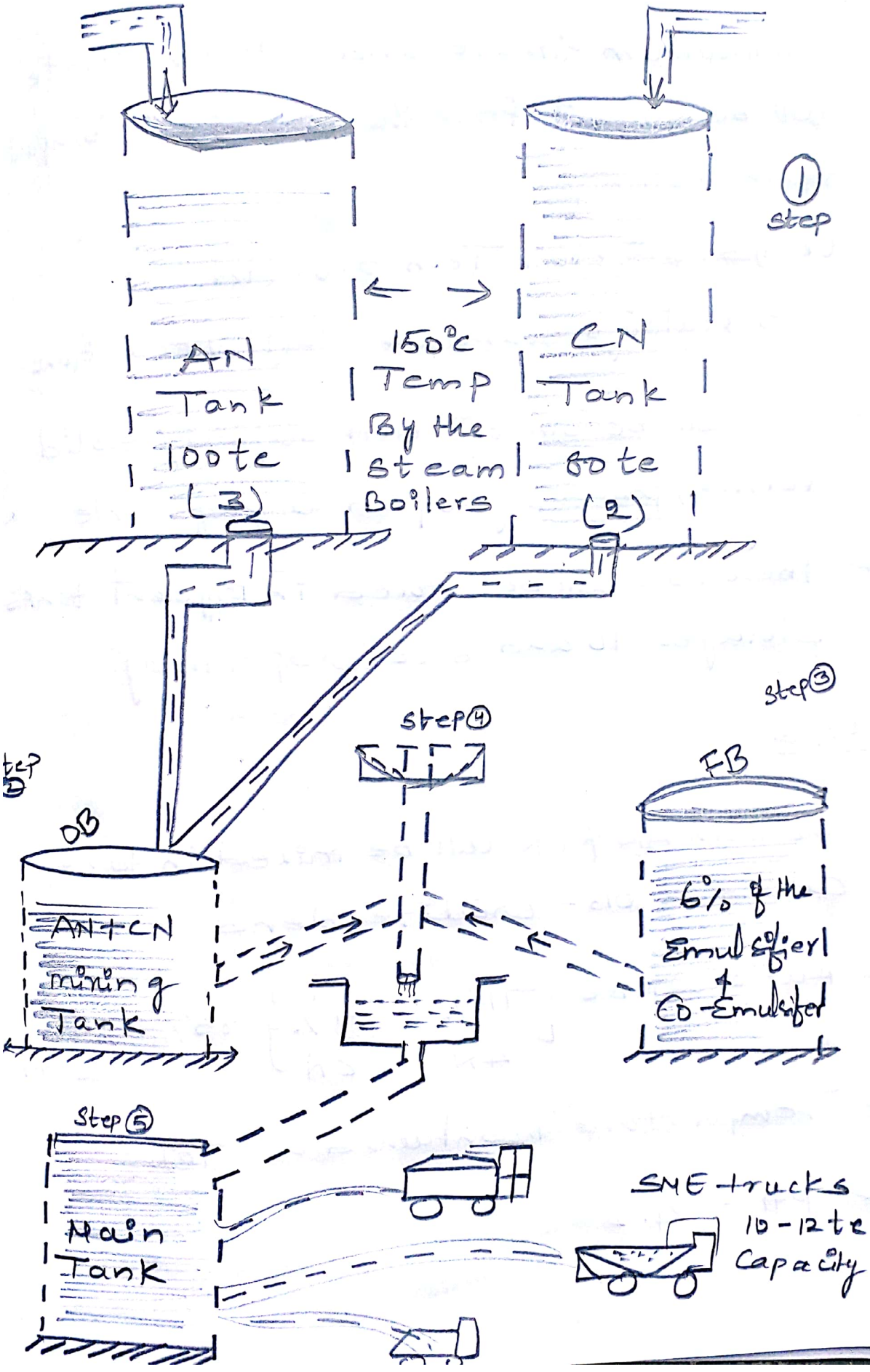
– The all above mentioned prills (chemicals) will be added in to mixing tank in different Bags, water will be added lateral total Convert into liquid form.

- The capacity tank around 20te
- Henamen used to maintain, adjust the pH value of it
- Guargum will be acted as a thickening agent
- The liquid will be pumped in to the tankers.
- Alluminum powder, Sodium nitrate and HDS will be added and pumped in the Hole along with the said liquid form explosive
- Aluminium powder added to Enhance the Energy and Sodium nitrate as gassing agent
- HDS will makes Explosive water resistant
- Site mixed slurry was their in Earlir in the Ramagundam (Before 30/10/2018) Due to some disadvantages of the SMS turned in to SME

Few Demerits :

- Combination of many chemicals
- Cannot store after loaded in to tanks
- For longer period, slurry will be solidified
- Poor water oresistant.

Site mixed Emulsion :



General layout & procedure going on in RG-II

Step ①

- Ammonium nitrate and Calcium nitrate will be Import from the chemical companies from bombay.

  Ex: 1) Smart chem Tech p.v. Ltd

  2) Rashtriya chemicals & fertilizers (Govt)

- AN can be Import both liquid / solid forms, propably liquid is preferable

- These both will be stored in different tanks Storages 10 and 8 te respectively

Step ②

- The Both AN & CN will be mixed in tank called as OB - Oxidizer blend

- Ratio will be {71% : 14%} 85% + 15%
  AN CN coater

- Temperature maintained at 70 I 2

- PH - 4.2

Step ③

✓ The core 85% of oxidizer will become 100% by adding Emulsifiers in FB – fuel Blend tank

✓ Main Emulsifier – Sorbitan monooleate
Co - Emulsifier – + Soya lecithin

✓ Fuel – HSD
High speed Diesel

Step ④

✓ Both oxidizer and Emulsifier will be mixed in Jet mixer with RPM – 1100 and stored in silo tanks.

Step ⑤

✓ Explosive will be pumped in to trucks From silo tanks.

– – –

✓ 1 : 2 will be added with explosive SN water

in to the holes.

SMS :

- This Explosive is not in the Cartridge form.
- The Components of the Explosive are Carried in the liquid form in different Compartments of the pump-truck from the Supplier's plant
- At the site, on starting the pump, the Components get mixed in the chamber and are pumped in to the hole through the hose-pipe.
- Since mixing takes place at the site, It is known as the site mixed slurry
- site mixed slurry only non-Explosive ingredients are stored at a warehouse and transported to the blasting site in a specially designed pump-truck.
- In Semi-gelled Conditions, pumpable slurries can be stored for 2 weeks in the truck without any adverse effect on the Explosive performance.
- one truck can charge nearly 25,000 kgf in one shift.

A small team of 5-6 professionally trained persons can load 50,000 – 60,000 kgf of the explosive in to large number of the holes in the single shift effectively.

PMS :

In this system, pre-mixed slurry is manufactured at the satellite plant located in close proximity to the mine site and its then transported to the site.

The explosives prepared under controlled conditions and exactly for the actual yield requirement is directly pumped in to the borehole.

Advantages

* Robust & Reliable system
* Explosive prepared under supervision

Dis-advantages

* Expensive to transport
* large safety arrangements
* Delivery of the single product

Comprehend(2nd Unit)

Topic name:

Date:

What you understand from the topic:

Rate yourself (10):

Rapid test

Comprehensive Scrutinizes

- Scrutinize Area:

- Define Problem?

- Root Cause:

- Control Measures:

- Your Perception:

- Any Enhancements:

PPT Talks

- Topic:
- Subtopic:
- Extracted Core Stuff:
- Pen the Illustrations:
- Mathematical terms:
- What you understand?
- Rate your friend(10):

Prototype Replicas

- Topic:
- Days spent:
- Team names:
- Expenditure:
- Stuff Acquired:

PASTE YOUR MODEL PICTURE HERE

Journal Interpretations

- Journal name:
- Title:
- Authors names:
- Publishing year:
- Synoptic abstract

- Pen the Illustrations:

- Gross theme:

- What you understand?

Journal Interpretations

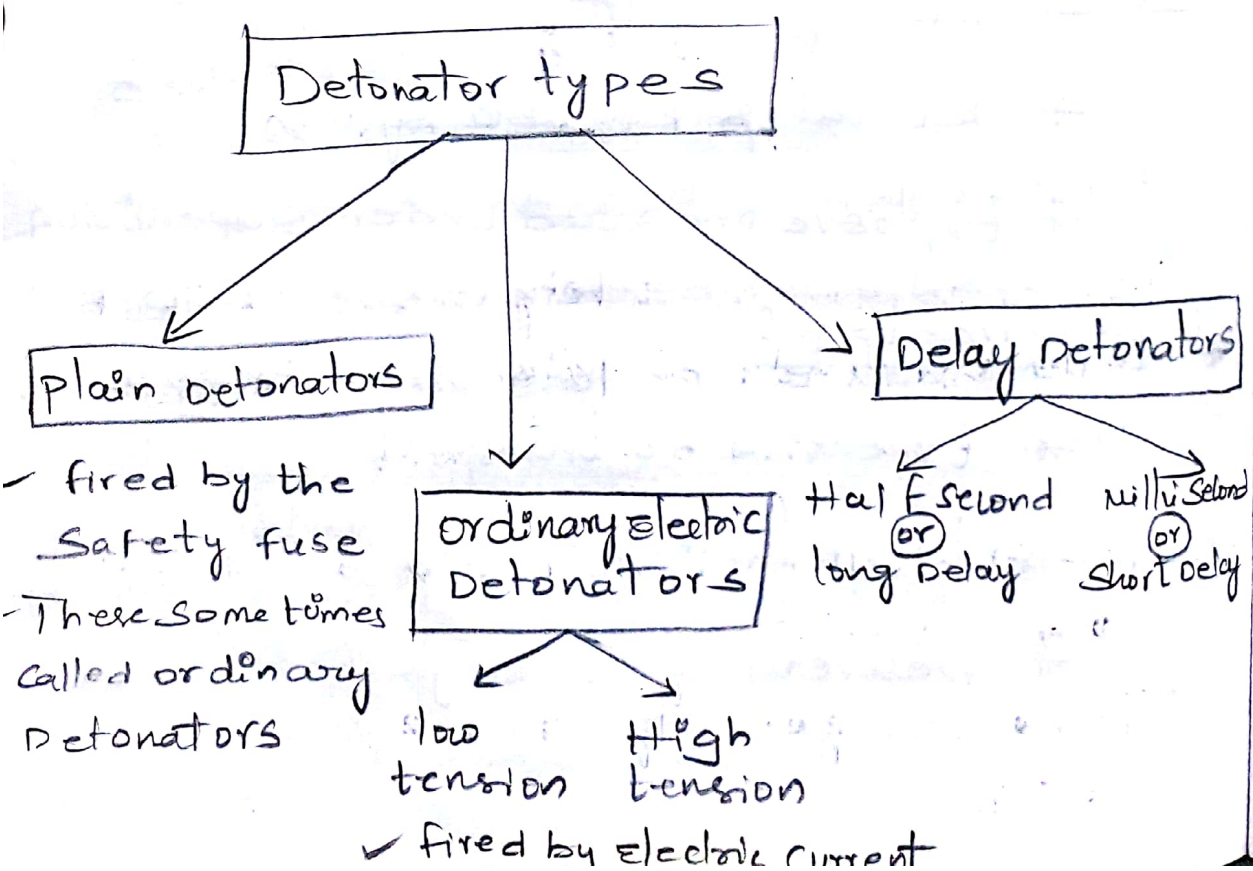
PASTE JOURNALS HERE

14/11/16

Explosives and Blasting methods

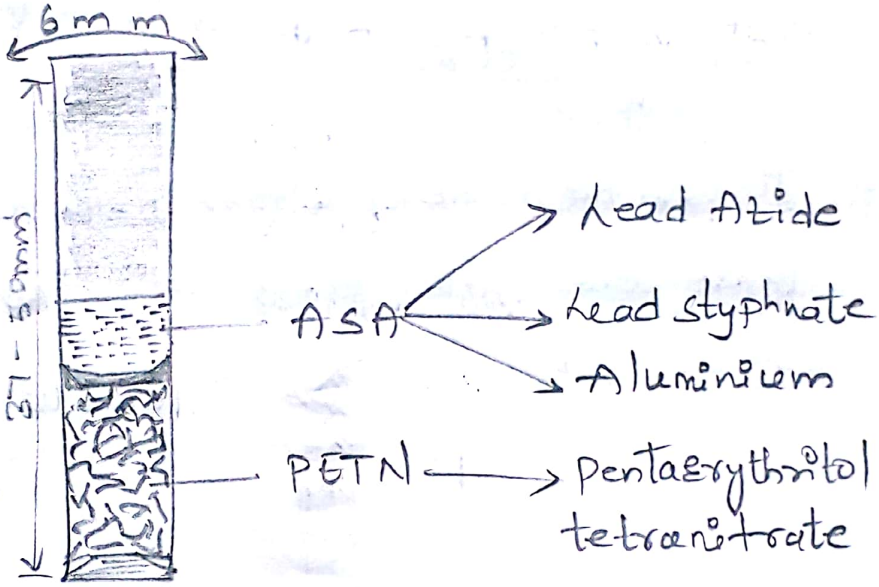
Detonators:

- It is generally a small copper or aluminium tube containing essentially a small auxiliary charge of the special explosive.
- Generally high explosives are initialed by the Detonators or Detonating fuse
- A chemical Reaction initiated by the flame or Electric current in the special explosive can build up very rapidly in to an explosion of sufficient intensity to project a detonation wave through the high explosion enclosing detonator



Plain or ordinary Detonator :-

- This one will be used together with the safety fuse to initiate cap sensitive Explosives.
- It most simple and Economical
- It is mainly used for the simultaneous firing of the multiple holes charged with explosive
- These are more effective in open cast dry Holes.

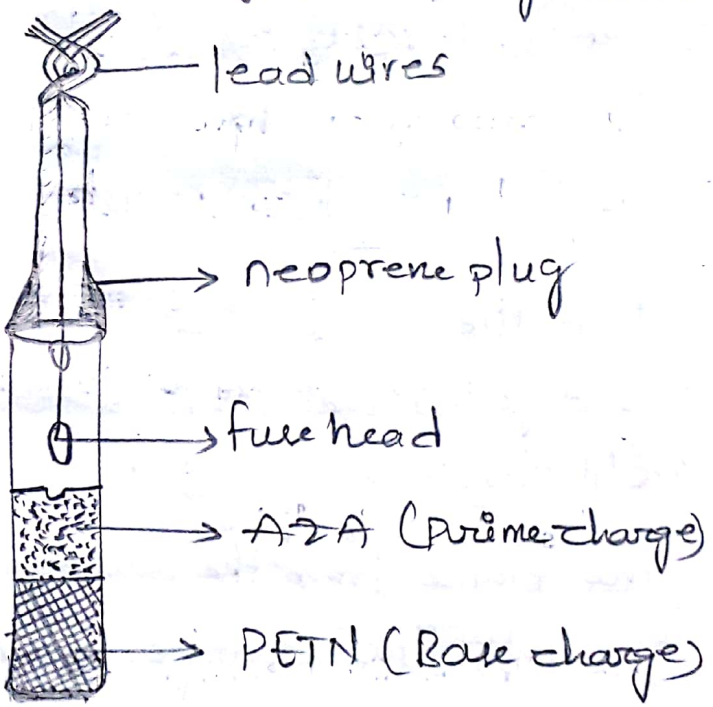


- Here the base charge is PETN and the prime charge is the AZA as mentioned in the illustration.
- The flame from the safety fuse will be pass first to the prime charge, later which initiates the Below base charge immidiatly.
- The Aluminium tube dia is 6mm ϕ 37-50mm long generally.
- There are generally manufactured in the 6 P & numbers.

- Let's suppose in 6 number detonator generally contains of the 0.22gm of PENT and 8 contains 0.45g of the PETN.
- ASA various generally 02 - 0.4 g.
- Scraper knife is used to cut safety fuse
- Make sure safety fuse crimp at open end of the detonator

Ordinary Electric Detonator :-

- It can be made of either aluminium or copper tube
- These are instantaneous type, no delay element.



- By comparing electric with the plain detonator In electric a fusehead is incorporating additionly for initiating / passing current to further prime and base charges for explode.

The initial shock wave is created by the vaporizing a length of the thin wire by the electric discharge.

while using electric detonator, it is mandatory to test for its proper continuity & Resistance by the galvanometer.

Extra care should be take while stemming in order to damage leadwires of the detonator

* Low tension detonator :-

The fuse head is the Assembly of the two brass strips which are connected to their lower leads by the fine wire bridge of nickle & chromium alloy thus forming a metallic bridge immersed in a bead of the ignition composition.

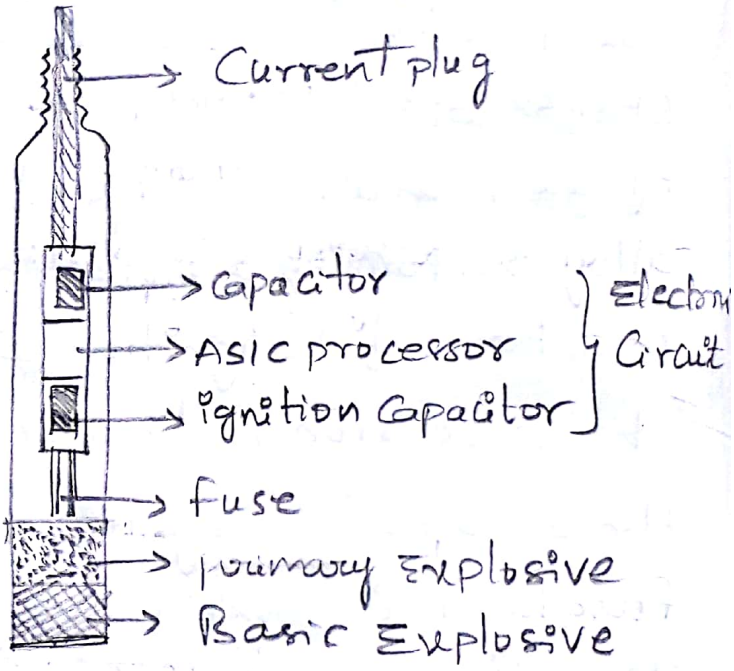
* High tension detonator :-

Here no bridge system will be consists, the fuse head is combination of the finely divided graphite to form a semi-conducting medium or chemical bridge.

The firing detonator requires minimum amount of the current is the 0.5A

Electronic Detonator :

- From the middle of the Eighties, several explosive manufacture began to develop Electronic delay Detonators.
- These accessories give, due to their great precision, excellent control over the fragmentation process, as well as the over vibration and the flyrock.



- In this device, the pyrotechnic delay detonator has an Electronic timing Circuit.
- Each detonator has a built in delay sequence that is designed during its manufacturing
- The delay number is desided by the Blaster
- The detonator described used with Sequenced Explosives that have different phases in their Circuits that go from 5 – 250ms, in Increase

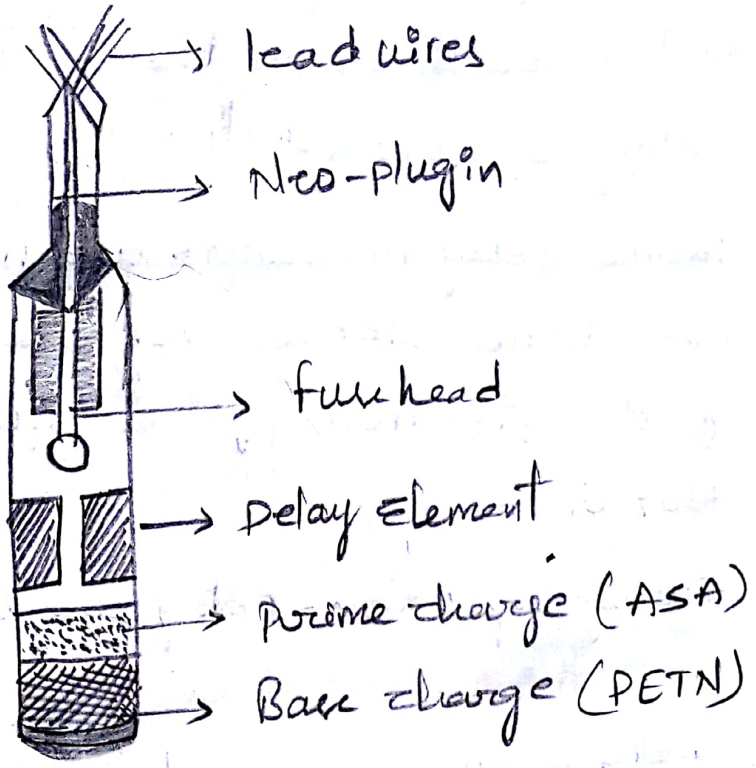
✓ The filter, in Combination with the toroid, gives Idle protection against the parasite currents, static electricity produced from the pneumatic charging of the Explosives or radio-frequency signals.

Delay Detonators :

✓ There will be generally low tension electric detonators with the delay element

✓ Half Second / Milli Second
(long delay detonator) (short delay detonator)

✓ It is almost like a plain detonator, But here the new addition is the Delay element

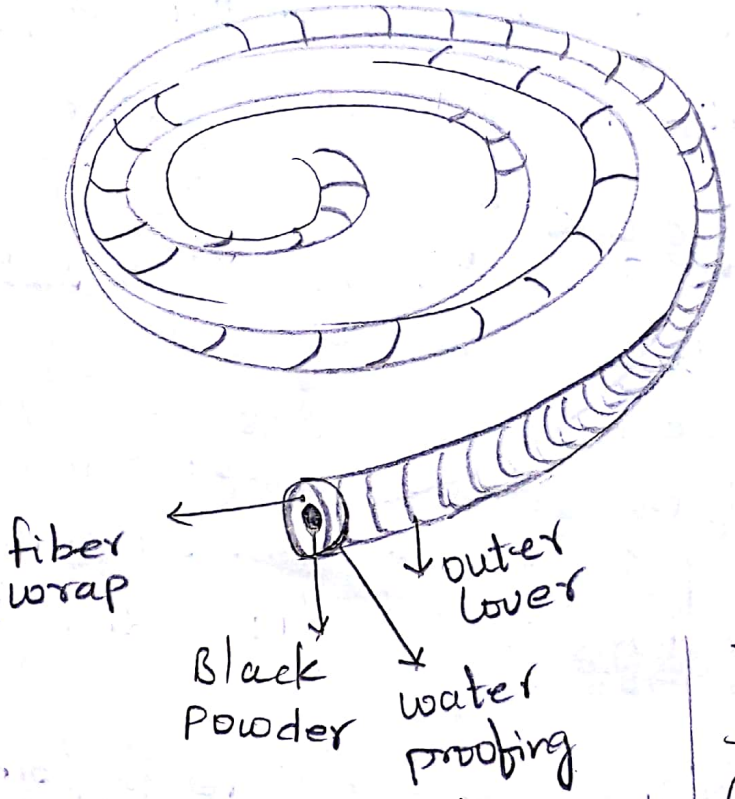


- It is also a simple Aluminium tube with the 6mm dia and 37-50 mm long.
- Filled with the 1/3 with ASA & PETN.
- Usually the prime charge will intiates the Base charge.
- Generally with 6 No detonator used.
- The Electric current will passes to prime and Base charges through the fuse head.
- Required current to ignite fusehead is 0.5amps
- Required voltage to Blast detonator is 3.5V
- Here a Delay element has Introduced between the fusehead and prime charge
- The Delay Element consists of the copper or Brass sleeve filled with the special Composition which Burns the specified rate and Delay obtained.
- Some Delay detonators are made with the antistatic sleeve over fusehead as to give protection against static Electricity Hazards.
- Delay and Non-Delay are distinguished with the Colours of the lead wires.
- Delay number is stamped at bottom of the tube

Accessories :-

- ✓ Safety fuse
- ✓ Detonating cord
- ✓ Nonel
- ✓ Raydet
- ✓ Detonating Relays
- ✓ Cord Relays
- ✓ Exploder
- ✓ Crimper

Safety fuse :-



It is a simple stuborn wire Consist of the finely grounded Black powder.

- Cord Consist of the core of fine grained gunpowder. wrapped with layers of the tape or textile yarn and water proof Coatings
- Burning speed 100 to 120 sec/meter
- Safety fuses manufactures for various Conditions

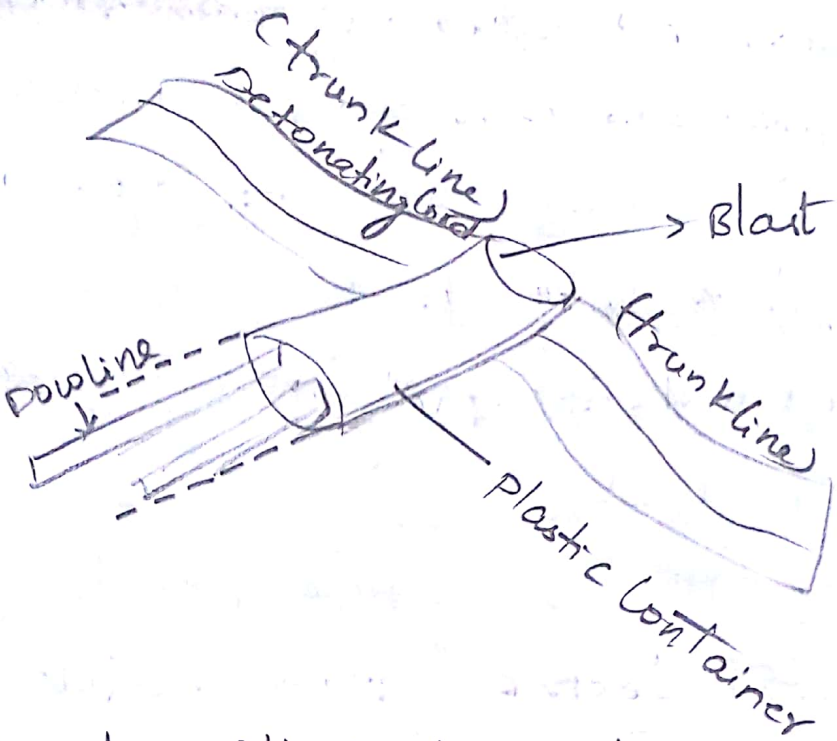
Dry Conditions	Damp Condition	wet / Rugged
* Double Bull Brand	* Blue Stamp	* Orange Colored plastic sheathed * Blue plastic

- It generally one end will be ignated, and the flame at uniform rate to ignate gunpowder which detonates detonator which detonate a High Explosive.

Detonating Cord :-

- Detonating cord (Detonating fuse) will resemble safety fuse, But Contains High Explosive instead of the Black powder.
- The first Successful one, patented in the frank in 1908.
- In starting the core Explosive in Cord was TNT, later it was replaced by the PETN
- The outer Covered with various materials like plastic.

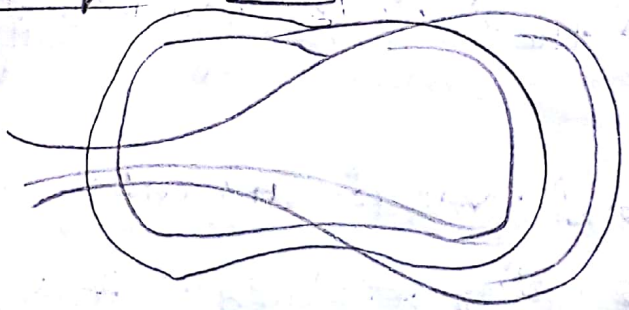
- Detonating cord has many applications in the mining
- Any number of the holes can be connected with it in just about any desired pattern
- Attached to the blasting charge and then knotted to the trunk line, It is fired by means of either a fuse type or Electric Blasting cap.
- generally the trunk lines will be cut and insert delay detonators for the incorporating delay period about 5-25 ms
- Cordtex is also a type of detonating cord.
- It's VOD generally 6000-7000 m/sec
- Handle and use detonating cord with care to avoid damaging the cord during loading and hooking up.
- The main line of detonating cord, which runs through the area where you have placed explosive charge is called "trunk line".
- The lines of cord which run from this trunk line to the individual charges are called downlines or branch lines.



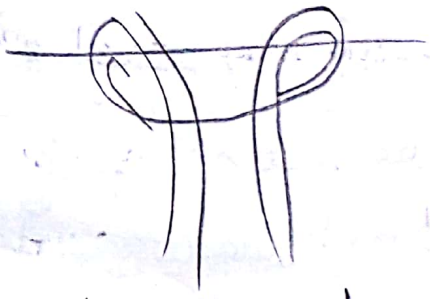
✓ The above illustration explaining, how the Detonatic cord Connected and The direction of same detonating cord, which passes to explosive is known as a 'trunk line'.

KNots for Detonating fuse Connection

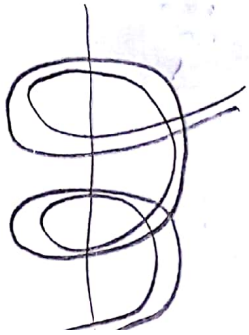
Square knot



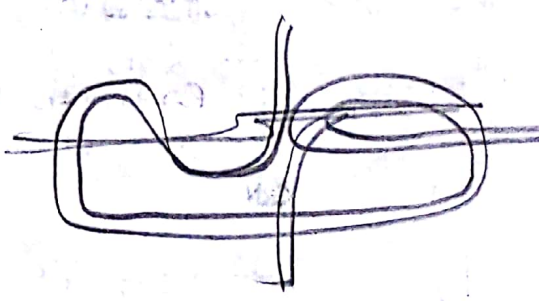
Double half hitch



Clove Hitch



Double wrap half hitch



✓ Keep all the detonating cord trunklines and branchlines free of loops, kinks that direct the cord back towards the oncoming line of detonation.

✓ Inspect all detonating cords before fire.

Nonel :

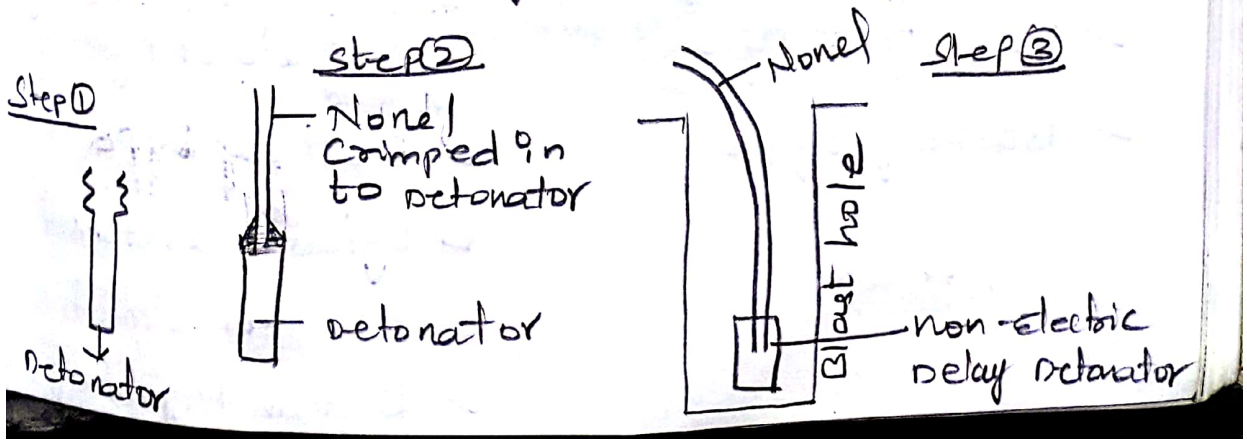
✓ It is a non-electric system, developed by the Nobel AB from Sweeden.

✓ Raydet is a one best type of the Nonel.

✓ It is a tube of plastic has 3 mm External and 1.5mm internal Diameter

✓ Inside of the plastic tube is Coated with the reactive substance that maintains shockwave at rate of 2000 m/sec which intiates detonators primary Explosive

✓ one end of the Nonel tube is Connected to the non-electric delay detonator and Crimped properly, other end is sealed



As shown in the figures, the nonel will be Crimped and lowered down in to the Blast hole.

- Advantage of Nonel is It offers Extreme Resistance to accidental initiation by the static electricity, stray Currents, Radio transmissions, flame and friction.

Crimper :

- It is a simple raid of the pliers to Crimp or press the end of the plain Detonator on a Safety fuse inserted in to detonator.

Exploders :

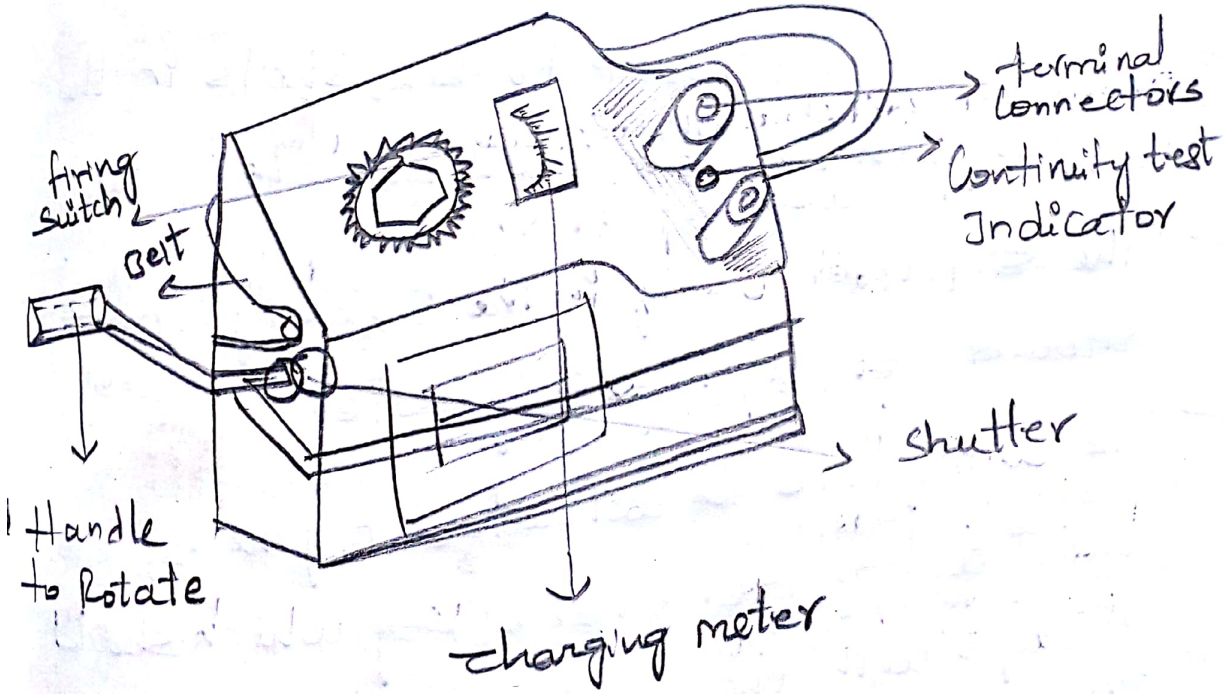
- These are portable apparatus which provides the Current necessary for the firing the Electric Detonators called Explo-der.

Exploder

- For single shot firing
  - ✓ Magneto or Dynamo
  - ✓ Battery type
- for multishot firing
  - ✓ Magneto or Dynamo
  - ✓ Battery type
  - ✓ Dynamo Condenser
  - ✓ Electronic multishot
  - ✓ Russian High frequency

Magneto or Dynamo single shot

- This consists of permenent steel magnete between the poles of which an armature revolves by the rotary Handle or by the means of the rack and pinior mechanism.
- The entire asembly is enclosed inside the casing
- There are two types, low tension & High tension
- For rotating half turn in low tension Exploder circales and open circuit voltage of 15 volts, which provides the 0.5 amps of the current, High tension requires 125 volts



Battery single shot :

- Here current is provided by the dry battery cells connected in series.
- The generation of the current is independent and construction has no effect either the voltage or the current and ensures the misfire due to the faulty manipulation.
- This type of the exploder possesses no inductance therefore no spark are produced.

Magneto Exploder Multi-shot :

- This is similar to similar to single shot magneto type exploder.
- The exploder fires up to six shots in the series with the six shot exploder.
- The exploder using in the underground should be intrinsically safe.
- The armature is actuated by the special twist action detachable key which should always with the shot firer.

Russian High frequency Exploder :-

- In this Exploder the output takes the form of an alternating current with the frequency 35 kilo/sec.
- Safety is pre-sumably obtained because any spark that may occur is extinguished when the magnitude alternating output current passes through zero and sparks are limited to about 10 m.s in duration
- In this Exploder the high frequency A.C current instead of D.C ensures method of powerful and safe multi-shot firing.

Raydet :-

- It is also similar to the Nonel, some how.
- It Consists of the plastic tube Carrying a very small Quantity of the explosive material on its inner surface.
- No.8 Detonator or Delay Detonator will be generally used at end of Raydet (Crimped)
- Raydet is generally initiated by the Detonator or the detonating cord
- length of tube varies from 3m to 45m
- Delays from 0-15 number, 1 Delay = 50ms

Electric firing & Non-Electric firing system

Electric firing system :

- Here the electric firing means, the fire given electrically by means of shock, which is given by the Exploder
- Many exploders are Exisists like magneto and Battery type
- Ultimately the shot firing cable will be Connected to the Exploder, and another End Connected to the detonator to intiate it.
- It is called electric firing

Non-Electric firing system :

- As per rules and regulation the non-electric firing was banned.
- Non-Electric firing incorporates with the Safety fuse
- one end of safety fuse Connected to the detonator / some times directly lowered down in to the hole, and another end surface will be ignited simply with matchstick.

It is called Non-Electric firing

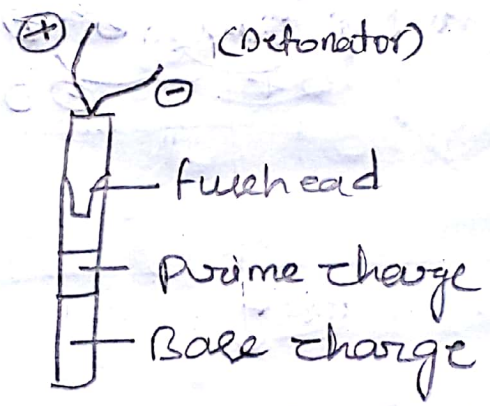
Electric & Non Electric initiation System

Electric initiation

Its very clear the fire producing from the starting point is called as firing system It is Different from the initiation system

Here Electric or Delay Detonator will be used, inserted in to the Cartridge of the Explosive and the Detonator lead wires will be wired out from the Blast hole.

Step ①

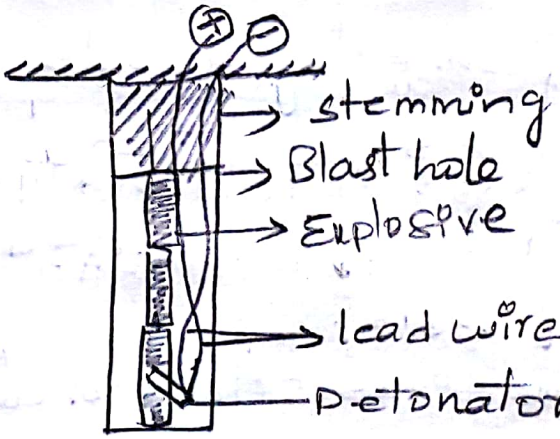


and

Step ②

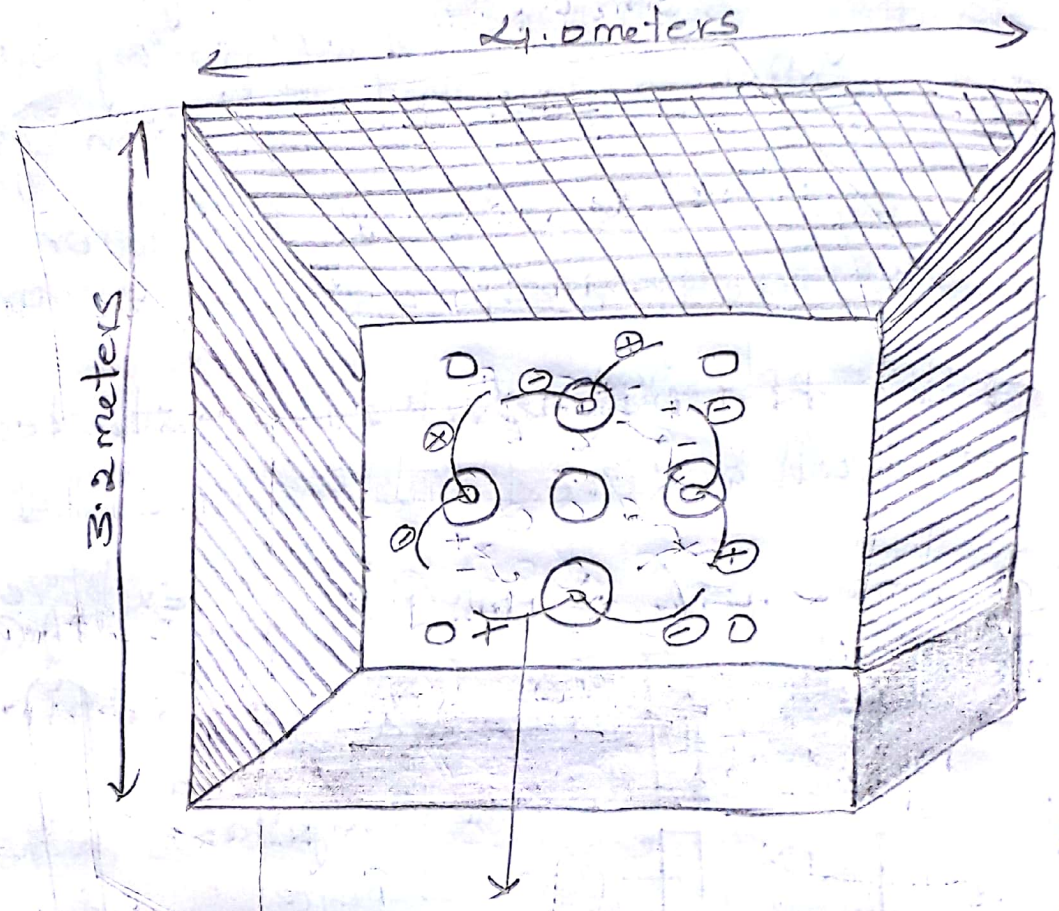
Detonator inserted in to the Explosive Cartridge, this is known as priming

Step ③



The detonator lead wires have wired out from the Respective Holes.

As shown in the illustrations, Each Hole Each Detonator's two plus and minus lead wires will be drawn and Connected with Orest hole lead wires in opposite manner.



* Every hole lead wires ⊕ and ⊖ are drawn and Connect to its opposite sign of the lead wire as shown in illustration.

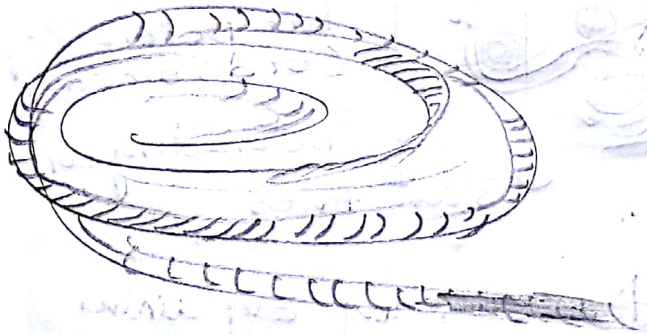
* The Digram showing a cut holes in the Burn cut pattren.

* After Connecting all holes of the Burncut Including dreelers, the last ⊖ and ⊕ lead wires will be usually Connected to the short firing Cable.

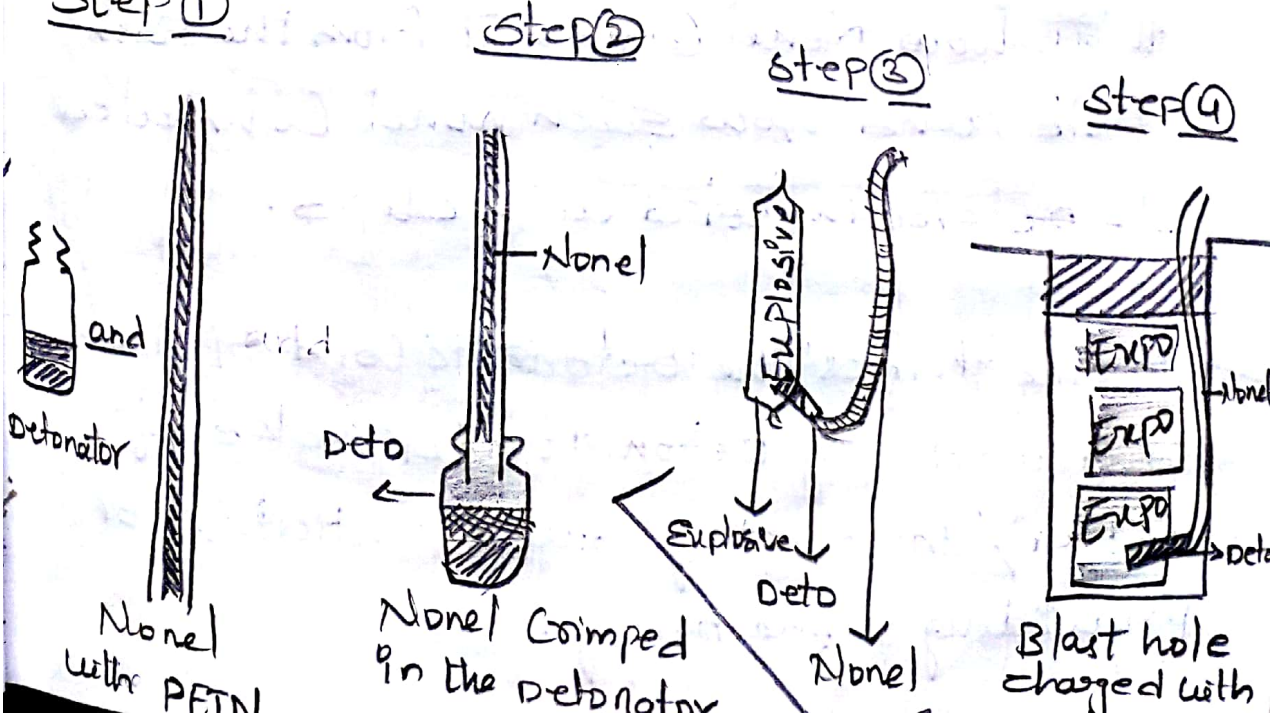
* Some times Detonator also added.

Non-electric initiation :-

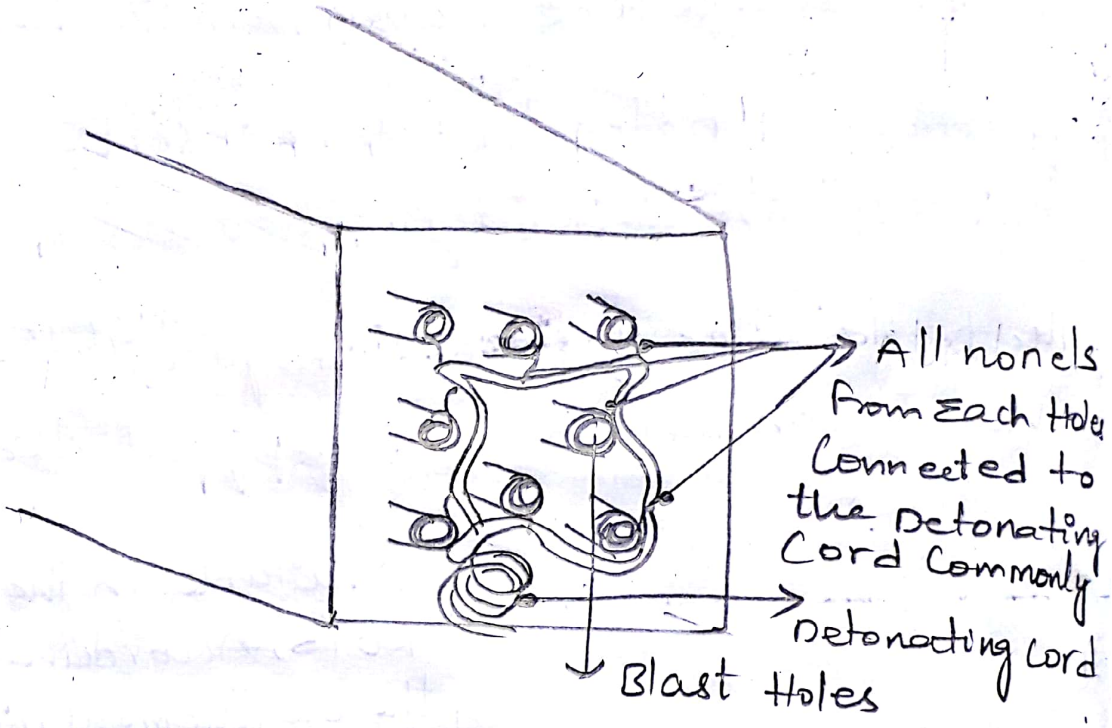
- ✓ As mentioned, Nonel is a non-Electric detonator having a small quantity of the PETN in the plastic tube which carries the initiation wave Efficiently.
- ✓ Nonel will be Crimped one End in detonator another End will be drawn from the hole.
- ✓ The Crimped detonator will be inserted in to the Explosive Cartridge.
- ✓ The trade name of Nonel is Raydet, It is available in meters accordingly selected.



Available in the Rolls, According to the requirement, meters will be selected



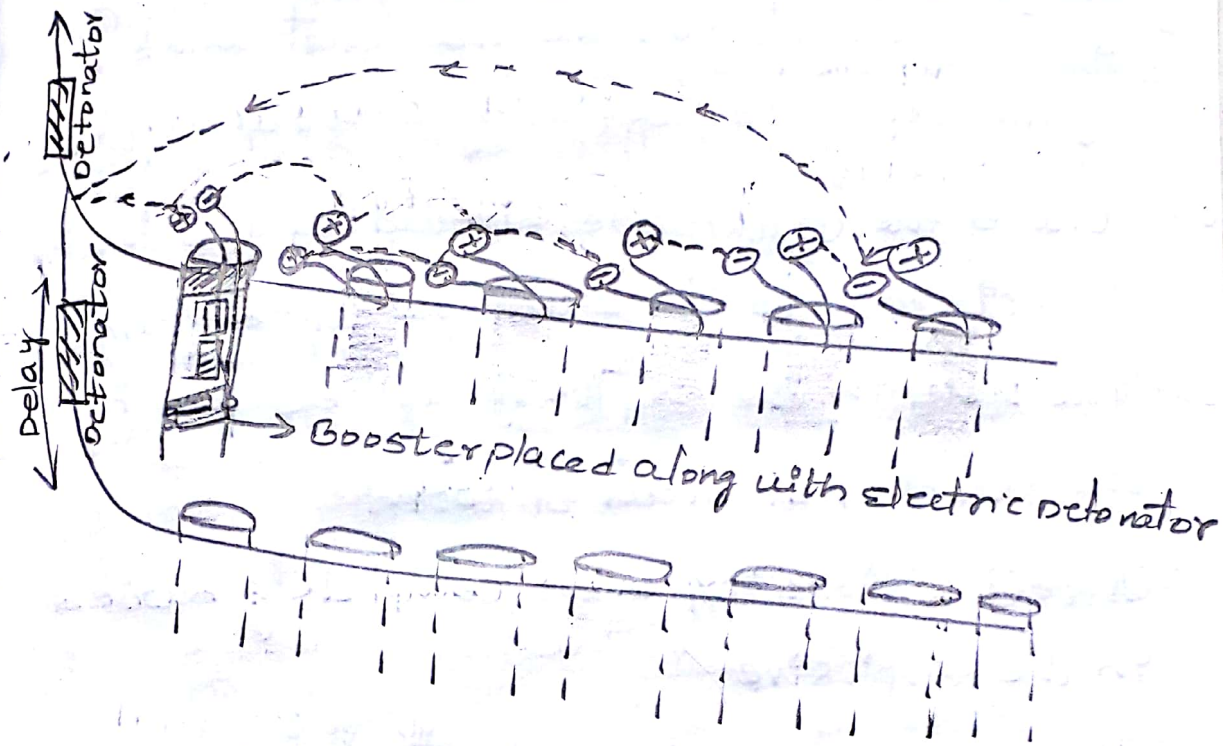
- As mentioned in steps, the nonel will be crimped in the detonator, the detonator may be a delay or plain detonator.
- Inserted in to Explosive.
- The Nonel drawn and Connected to the detonating cord, Cordtex.



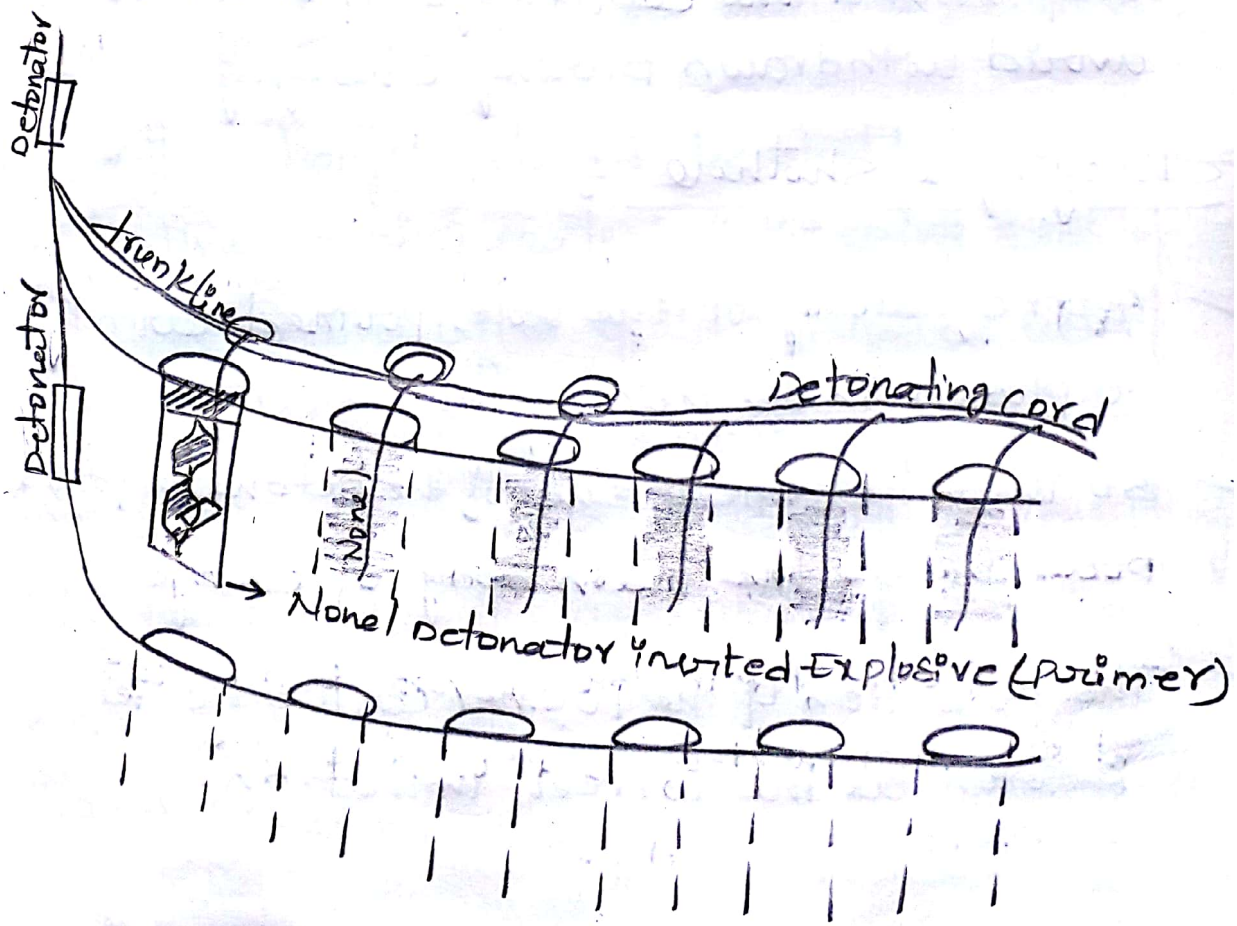
- The above illustration clearly Explaining that how Nonel Came out from the Each Hole, and how Each nonel Connected to detonating Cord with Clips.
- Sometimes the detonatic Cord spliced and add any detonator for sake of Better/Increasing shock initiation or providing more delay.

General Connections in the opencast

Electrical Initiation :-



Nonel Electric Initiation :-



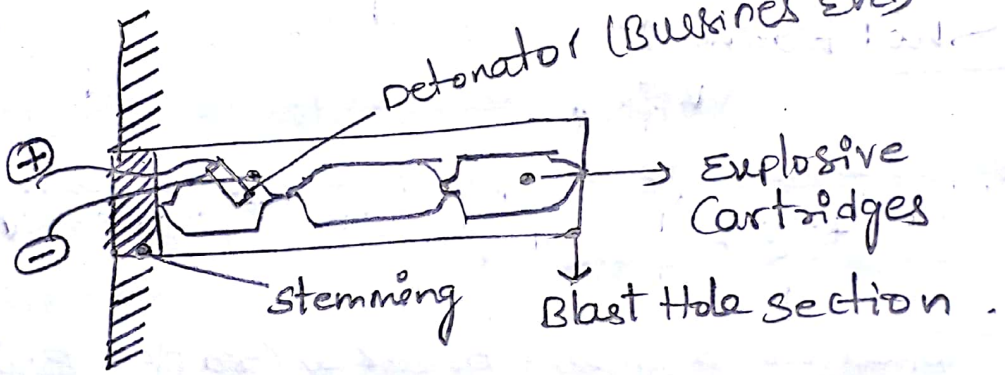
preparation of charge :-

- The charge for the Blasting hole may Consists of one or more Cartridges.
- It is desireble to have the least number of the seperate cartridges as far as possible
- one of the Cartridge should have Detonator inserted in to it. such are called primers
- The hole in the Explosive will be done by the pricker of brass or wood
- Insert Detonator, until Completely buried in the Explosive
- The lead wires of the Detonator should wrap around the Cartridge in order to avoid withdrawn during charging

charging a shothole :-

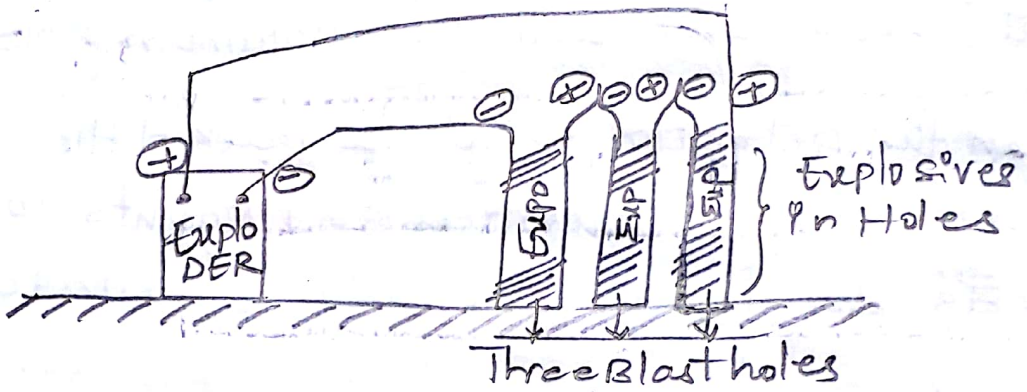
- After cleaning of the hole, Pormed Cartridge is placed in the hole
- so that "business End" of the Detonator points downwards the main body of charge
- The position of the Pormer Cartridge is known as the Direct initiation.

- The strongest wave is directed towards the back of the hole and chances of all cartridges being properly exploded are a maximum.
- Direct initiation is the best to prevent ignition of the fire damp, reduces risk of the blown-out shots, and will give maximum yield.
- When the detonator is at the back of the charge and the "business end" points towards the front of the hole is called as "Inverse initiation".



- After charge is placed, the shot hole is stemmed with stemming material, keeping Ends of the leading wires of the Detonators out of the holes.
- The stemming material should be consisting of the sand and clay in 3:1 proporation.
- The cartridges are usually 150-200mm long and 25-80 mm dia.

- The first 2 or 3 cartridges near the charge should be tamped lightly by the stemming rod.
- After that lead wires should connect to the Exploder in order.



Shot firing :-

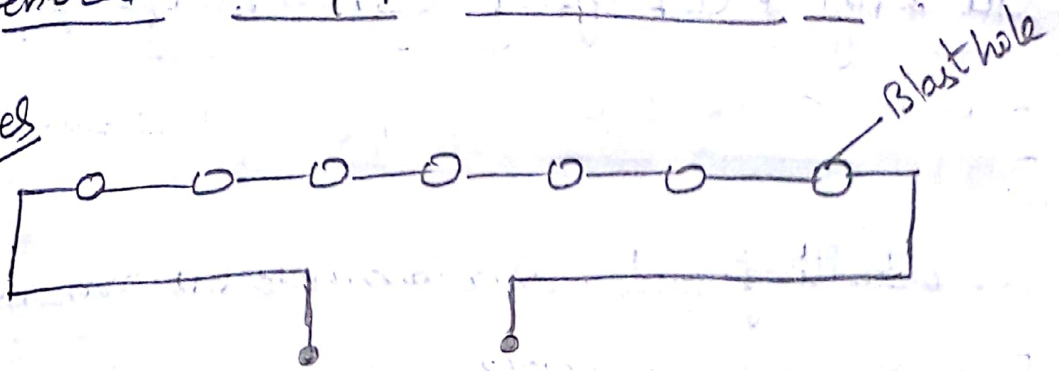
- procedure to adopt, fire shots using the Electric Detonator.
- Test holes if any breaks, cracks Exists If any found, Hole should not be charged
- Test for gases in the hole
- Spray stone dust or water from the 18m of the area
- Few of workers should prevent any body Entering area from 87m

Now Couple the firing cable to lead wires of the Detonator

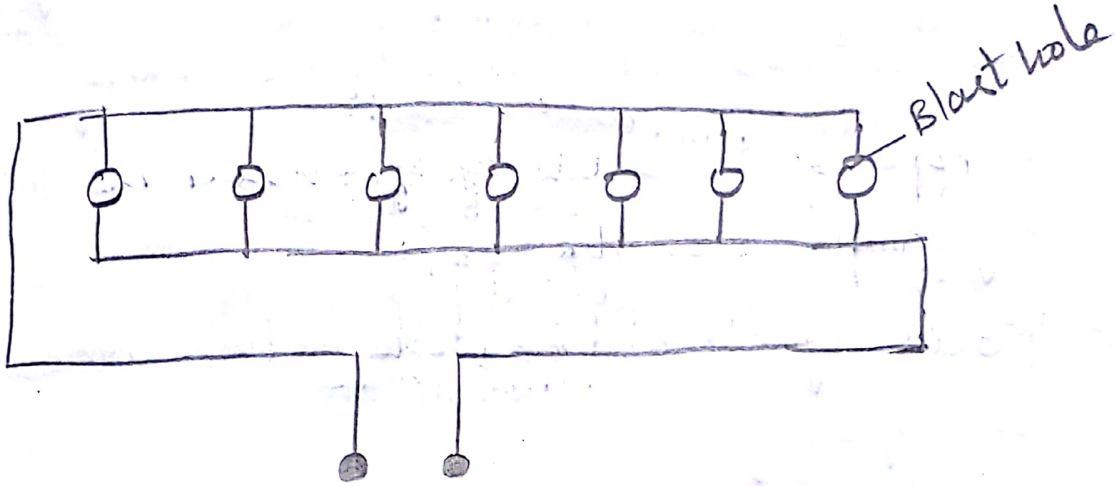
- If more than one shot to be fired, the

General series & parallel Connections :

Series



Parallel



- The Blaster should take shelter.
- The Coupled shot firing Cables Connect to exploder
- The shelter is generally 2 right angles away in underground and 500 meters in opencast
- Now Shout a warning again like "bhum-bum"
- Once again ensure that workers have taken Shelter.
- Now fire the shots by the sharp twist of the Exploder key.
- After blasting, allow the fumes & gases clear
- Examine the roof, sides and dress it properly
- At End of the shift, shotfirer should report how much Explosive used.

Drilling – charging – Stemming – firing as per CMR, 2017 – 192 :-

- No drilling should allowed unless it provides 0.3 cm of the clearance over the cartridge
- No shot hole charged, befor cleaning
- Before shot hole charging, should be suit-ably marked on the roof
- Priming should be done before immedite using only.
- Once priming, Detonator should not take out
- Belowground all shot hole Explosive should use common.
- In opencast, If two type of Explosives such orders should submit to Regional Inspector Before Commencing.
- Shot-firer should be Confident over the hole over charge / under charge.
- Firing apparatus should be approved by the chief Inspector.
- Every shot hole should be suitably stemmed with non-Combustible material inorder to prevent blown-out shots

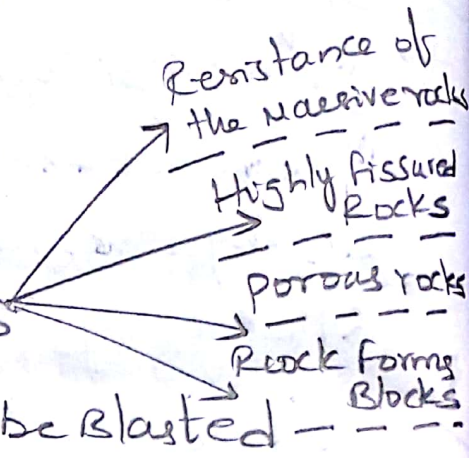
- only sand loosely filled in, soft clay lightly pressed or compact but not hard mixture of the sand and clay only should used. In any case, no coal dust should used for stemming
- No hole Hardly stem in insufficient place and no metallic tools should used, only scraper should used.
- It is better holes should fire by shot-firer who charged those.
- Surplus explosives should be Removed Before Connecting.
- No person shall remove any stemming or pull out any detonator Before Blast or the after misfire.

Selection of the Explosive :

- The selection of the type of explosive forms as an important part of the Blast design:
- Some factors that must be taken into account when Choosing a Explosive
- Such as cost of the explosive ed.

The parameters are :-

* Explosive cost
* charge diameter
* Rock characteristics
* Volume of Rock to be Blasted
* Atmospheric Conditions
* prevence of water
* Environmental problems
* Explosive atmosphere
* Supplay problems
* Fumes



Explosive Cost :-

- Always its better to opt less expensive explosive
- ANFO is one of the least explosive.
- But ANFO has poor density & not water resistant
- From economical point of view, the Best Explosive is not always a least explosive But rather the one that achieves the lower Blasting costs

Charge Diameter :-

- The Holes from 50-100mm, ANFO is efficient
- For larger Holes, Bulk Explosives like the ANFO, Slurries, Emulsions are more appropriate

Rock characteristics

- Geomechanic properties of the Rockmas to be Blasted make up the most important group of the parameters.
- Diffent Rocks Exists like Massive Rocks, Highly fissured, porous and Rock forms Blocks
- For Massive Rocks, Requires High strain Energy Explosives to create large number of surfaces
- In fissured Rocks, It Requires High gas energy like ANFO needed to develop radial cracks
- Porous Rocks, Requires with low VOD & Density like ANFO.
- In Forming Blocks, required ET/EB Balanced like ANFO is required.

Volume of Rock to be Blasted :

- In large operations, the Quantity of the Explosive such as to Consider its use in Bulk form, as it makes mechanised charging possible from the transport units themselves, It will reduce labor costs and making better use of volume of the rock drilled.

Atmospheric Conditions :

- NG based Explosives may tends to damage at 8°c, so NG based should use. In the lower freezing temperature – 20°c.
- ANFO is generally not affect by there Conditions.

Presence of water :

- All Explosives are not water resistant, for making water-resistant even it increases the cost of the Explosive. So It is Important to choose Explosive according to situation
- Generally If water presents, pulverized ANFO will be used with density 1.1 g/cm^3
- If water is more in the hole, then the hole should be Suitably Dewater and hole should water Lined than Bulk ANFO should use.

Environmental problems :

- The main two problems are ground Libration and air blast
- So the Explosive should'nt produce both.
- So Sometimes instead of slurry explosive ANFO use.

Fumes :-

✓ The Explosive should not produce toxic harmful gases, such as Co content

✓ If the Oxygen balance is good, it produces generally less fumes.

✓ Explosives in plastic Containers produces generally lot of fumes

✓ Gelatin explosives are good.

Supply problems :-

The final factor is availability

If the magazine is nearer or long should be taken in to account.

Misfires :

When a Detonator fails to Explode, or after Exploding fails to Blast the charge of the main Explosive Cartridge, known as "Misfire".

The Reasons may be :

- Defective firing Exploder
- Bad Explosive / Detonator
- Broked leads of detonator, Brokon shot firing Cable, Bad Connections.
- Short Circuit of the Cable

PreCautions Against Misfires :

- Exploder should be Examined once Every three months by the Competent person.
- Good Quality Explosives only should use
- Better to have two single core Cables for the shot firing seperated by the good distance, Instead of the twin core cable.
- All Circuits should be tested for Continuity test by the galvanometer.

Dealing with misfires :

- If the Shots are fired with the safety fuse up to 30min no one should go to site
- If Electric detonator, up to 5 minutes

- If the misfired shot does not Explode, the shot should be dislodged by the drilling another relieving hole in atleast 0.3 m away from the mis-fired hole and then Blasting it.
- The new hole should drilled by the person who knows perfectly about misfired shot
- During drilling, Drill Bit should not touch the misfired shot.
- After the relieving shot has Blasted the rock, a Careful Search for misfired Cartridges and Detonator should be made in the presence of the shot firer in material brough down by the shot
- If the misfired Explosive is not traced, the material should be loaded in the Seperate tub, Distinctly marked, then Surface search.
- If anything found (those should be destroyed
- Except in the Case of the Coal mines where the Regulations Correctly in force prohibit the Placing of the second charge in misfired shot and the hole is re-primed and fired.

Comprehend(3rd Unit)

Topic name:

Date:

What you understand from the topic:

Rate yourself (10):

Rapid test

Comprehensive Scrutinizes

- Scrutinize Area:

- Define Problem?

- Root Cause:

- Control Measures:

- Your Perception:

- Any Enhancements:

PPT Talks

- Topic:
- Subtopic:
- Extracted Core Stuff:
- Pen the Illustrations:
- Mathematical terms:
- What you understand?
- Rate your friend(10):

Journal Interpretations

- Journal name:
- Title:
- Authors names:
- Publishing year:
- Synoptic abstract

- Pen the Illustrations:

- Gross theme:

- What you understand?

Journal Interpretations

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20/11/16

Unit – IV

Transportation of the Explosives

procedure to grant licence for transport of Explosive

- A applications should made in form 26 and application form-2 along with the fee of the scrutinity 20/- Rs
- A license fee of the 150/- Rs to transport the Explosives / annum should be paid in form 26.

Maximum weight of the Consignment allowed:

- A 10T or maximum Carrying capacity of a road van licensed under the Explosives Rules by the Regional transport authority which ever is less, any one carriage other than the Railway wagons.
- 10T or Half of the Carrying Capacity of the wagon which ever is less.
- No mechanical propelled vehical shall be used the transport of the Explosive unless it is approved in writing by the chief inspector
- Not more than 200 detonators are transported in a vehical at a time.

- The detonators are packed suitably in a wooden Box
- The wooden Box containing detonators is placed inside an outer metal case of Construction approved by the chief Inspector.
- The outer metal case shall be suitably Bolted to the floor of the vehicle so that Container does not move about while the vehical is in motion.
- No persons shall ride on the rear portion of the vehicle.
- All vehicles for Carrying Explosives should be Conceptually marked with the words "Explosives" in a white on red letters on the Both sides of the Explosives. And the size of letters should not be less than 15cm in the height.
- They should be properly locked during the transport and should not be loaded or unloaded before sunrise or after sunset
- No Explosives should be brought out for the loading, unless the vehicle is ready for the transportation and Brakes set properly.

- The vehicle should have 2 fire Extinguishers for the transportation of the Explosives.
  * Carbon tetra chloride type for petroleum
  * Carbon dioxide under pressure type for the electrical fires.
- Explosives and the Detonators should not Carried in the same vehicle.
- The vehicle should drive by the Competent person and no passengers allow Except the helper and helper age should more than 18.
- The van of the explosives should avoide the as much Crowded places like towns. If unable to avoide, special permissions should obtain from the district authority.
- The vehicle should not be stopped on the way in Crowded places.
- It is preferable not to retuel a vehicle loaded with the explosives Except under Emergency. And Engine should be turned off while fueling.
- The vehicle should not be taken to a garage of Repair shop when loaded with the Explosive and shall not be parked in Congested places.
- Transportation of Explosives and accessories from Either manufacturer to the user is governed

by the various provisions of the Explosive rules, 1983

✓ Every vehicle used for the transport of Explosives shall be Carefully inspected Every 24 Hours by a Competent person to Ensure that:

→ A: fire Extinguishers placed or not

→ B: Electrical wiring well insulated or not

→ C: Chassis, Engine & body are clean and free from the surplus oil & grease.

→ D: Tankfull and feedlines should not be leaked or loose to flow.

→ E: Lights, breakes, steering in good Condition

→ F: The Report of every inspection made under Subclause (A to E) shall be Signed and dated by the Competent person.

Transport of Explosives as per CMR 2017 (167)

1) while Explosives are being Carried on a ladder, Every Cask or Container shall be Securely fastened to person Carrying it.

2) No person other than shot-firer shall Carry any Priming Cartridge in to shaft which is in Course of the being sunk and no such Cartridge shall be Carried Except in thick felt bag.

(188)

Transportation of Bulk Explosives as per CMR 2017

- The condition and other details for the transport of the Explosives in Bulk shall be specified by the Chief Inspector in a general order.

Reserve station (189) CMR, 2017 :

- No Case or Container Containing Explosives shall be left or kept in a mine Except in a place appointed by the Manager for the purpose and legibly marked "RESERVE STATION"

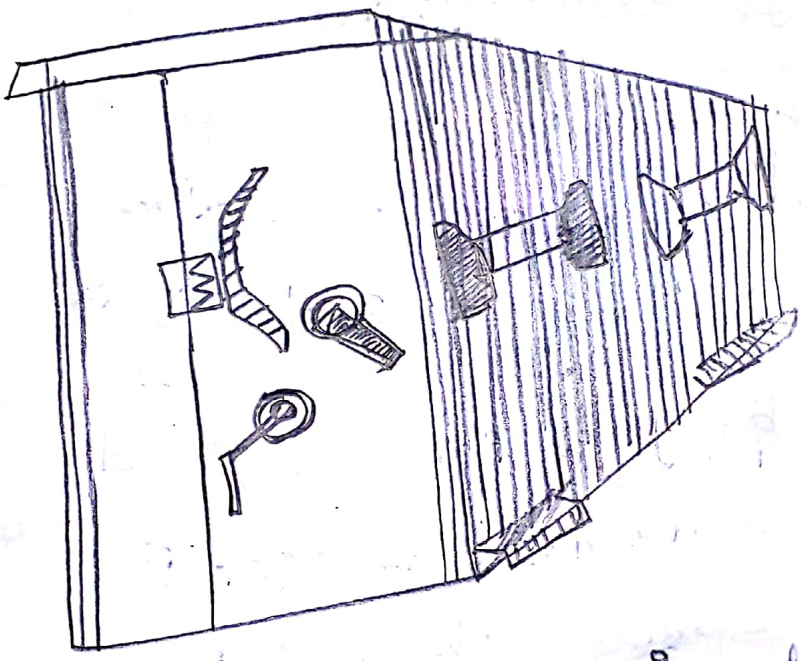
Storage & Handeling of the Explosives :

- A place or Building where Explosives and the Detonators are stored called a magazine
- A magazine Construction has to be approved by the Inspector of the Explosives.
- Certain safe distances are specified for the magazine site and they specify the minimum Distance of the Residential Quarters, Public roads. from the magazine.
- There distances depends up on the Capacity of the magazine, larger Capacity requires longer safe distance.

- Small magazines in the mine premises are according to Licencee in form J.
- Such a License permits magazine owner to store up to 45 kg of gun powder, 5 kg of other NG Explosives (nitrate mixture) and any Quantity of safety fuse.
- The large magazine in the mine premises are the according to licencee in form 'L' for storing high explosive up to 25,000 kg and 2,00,000 Detonators.
- An application in form C & D should be made to the Regional Controller of Explosives together with six copies of site plan and magazine Constructional details.
- Then the will forward all the Documents to chief Controller of the Explosives (CES)
- CES will then issue a form 'E' plus a draft copy of the licence "L" and will also pass one copy of the site plan to District magistrate who will issue a " No objection Certificate".
- Based on the procedure, the CSE will allow the applicant to proceed ahead with the Construction of the magazine and also issues a licencee in Form 'L'.

✓ on completion of the building the Regional Controller will inspect the magazine and the Endorse the licence which must be renewed annually.

Portable Magzine:



✓ A portable magazine requires a lineence from the Chief Inspector of the Explosives. It should be located on the ground about 5m x 2m keeping the following the safe distances

i. form the buildings, huts, places of worship officers, houses, schools and factories
ii. From all roads, rivers, market and playgrounds.
iii. From overhead high tension electric lines with in 91m

Comprehend(4th Unit)

Topic name:

Date:

What you understand from the topic:

Rate yourself (10):

Rapid test

Comprehensive Scrutinizes

- Scrutinize Area:

- Define Problem?

- Root Cause:

- Control Measures:

- Your Perception:

- Any Enhancements:

PPT Talks

- Topic:
- Subtopic:
- Extracted Core Stuff:
- Pen the Illustrations:
- Mathematical terms:
- What you understand?
- Rate your friend(10):

Prototype Replicas

- Topic:
- Days spent:
- Team names:
- Expenditure:
- Stuff Acquired:

PASTE YOUR MODEL PICTURE HERE

Journal Interpretations

- Journal name:
- Title:
- Authors names:
- Publishing year:
- Synoptic abstract

- Pen the Illustrations:

- Gross theme:

- What you understand?

Journal Interpretations

PASTE JOURNALS HERE

23/11/16

6th Unit

Rock Breakage Mechanism

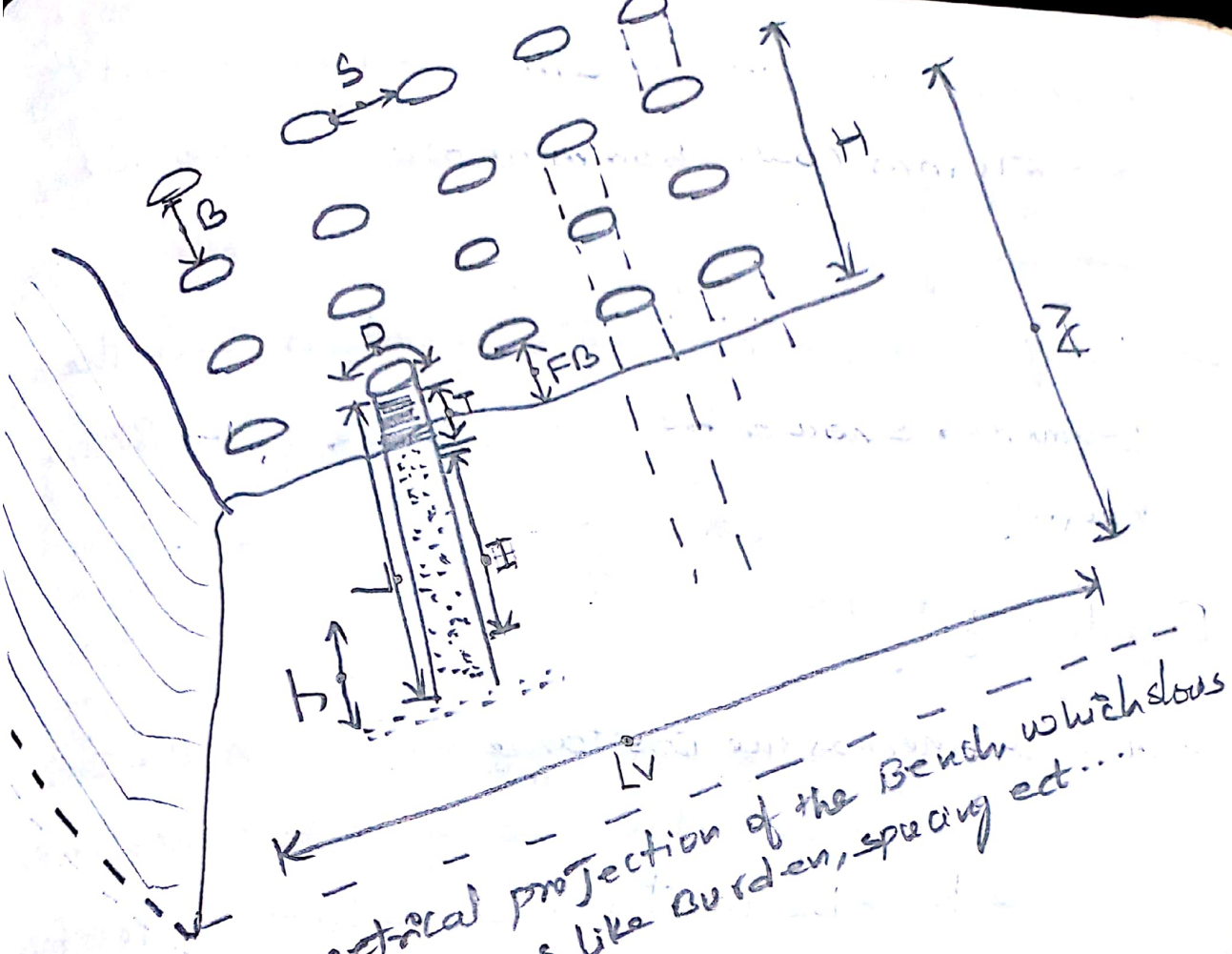
Affecting parameters on Rock breakage :

- Geometric parameters
- physicochemical parameters
- Time parameters

} Blast Design parameters

Blast Design parameters :

* Height of the Bench = H
* Blast hole Diameter = D
* Drilled length of B Hole = L
* Diameter of explosive charge = d
* Burden = B
* Spacing = S
* Length of Blast area = LV
* Width of Blast area = AV
* Stemming length = T
* Subgrade Drilling = J
* Charge Length = I
* Effective Burden Dist = Be
* Effective Blast Hole spacing = Se
* Delay = tr



Geometrical projection of the Bench which shows it's parameters like Burden, spacing ect....

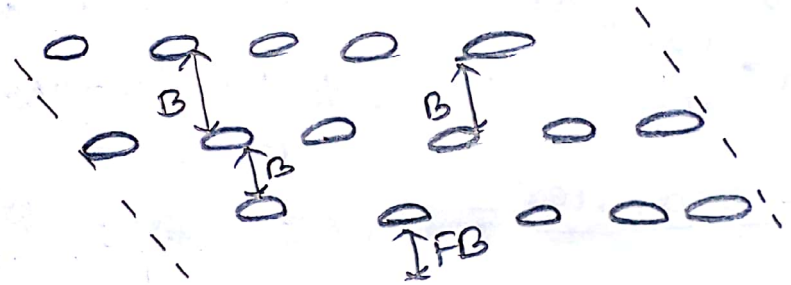
Blast Hole Diameter :

- Blasthole diameter depends on following factors
  - * Degree of fragmentation required
  - * Capacity of the loading Equipment
  - * Cost of Drilling and Blasting
  - * properties of the Rock mass.
- The Drilling and Blasting will Become Economical with increase in the Diameter.
- Hole Dia varies from 35mm small benches up to 410mm in large benches.

- In India 100-150 mm in Limestone mines and also 150-270 mm coal, 160 mm above in Iron mines are using
- Langefors & Kihlstrom suggested that the Diameters should be 0.5 - 1.25 % of the Bench height.

Burden :-

- It is defined as the distance between the Individual Rows of the holes. It is also used to describe the Distance from the front row of the holes to freeface



- usually Burden will also known as the vertical distance between the two holes.
- If Burden provision is not up to the mark, Rock breakage will obtained properly which tends to Improper fragmentation.
- Some of empirical formulas of Burden.
  - → B = 24D + 0.65 (Vutukuri)
  - → B = (25-30)D (Hagan)
- The above will give required Burden.

Spacing : It is a Horizontal parting between in the any row of two holes

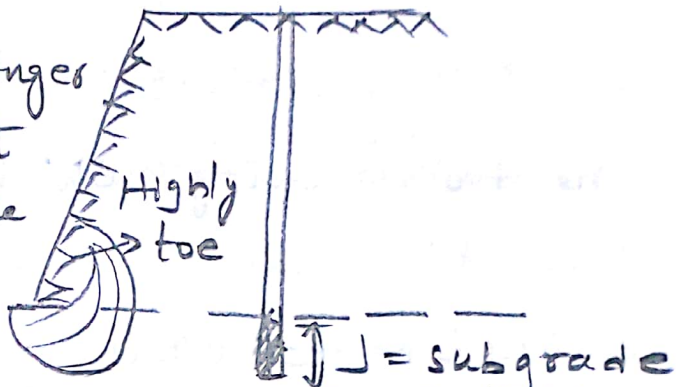
$S = (1.2 - 1.5)B$

Subgrade Drilling :

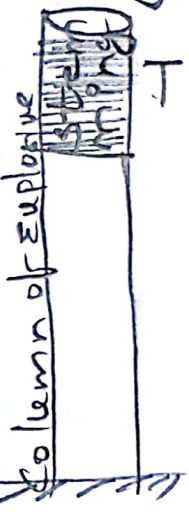
- Holes are drilled longer than the Bench height to avoid and Enhance toe formation

$SD = 0.1 * H$

$SD = 0.3 * B$



Stemming Length :



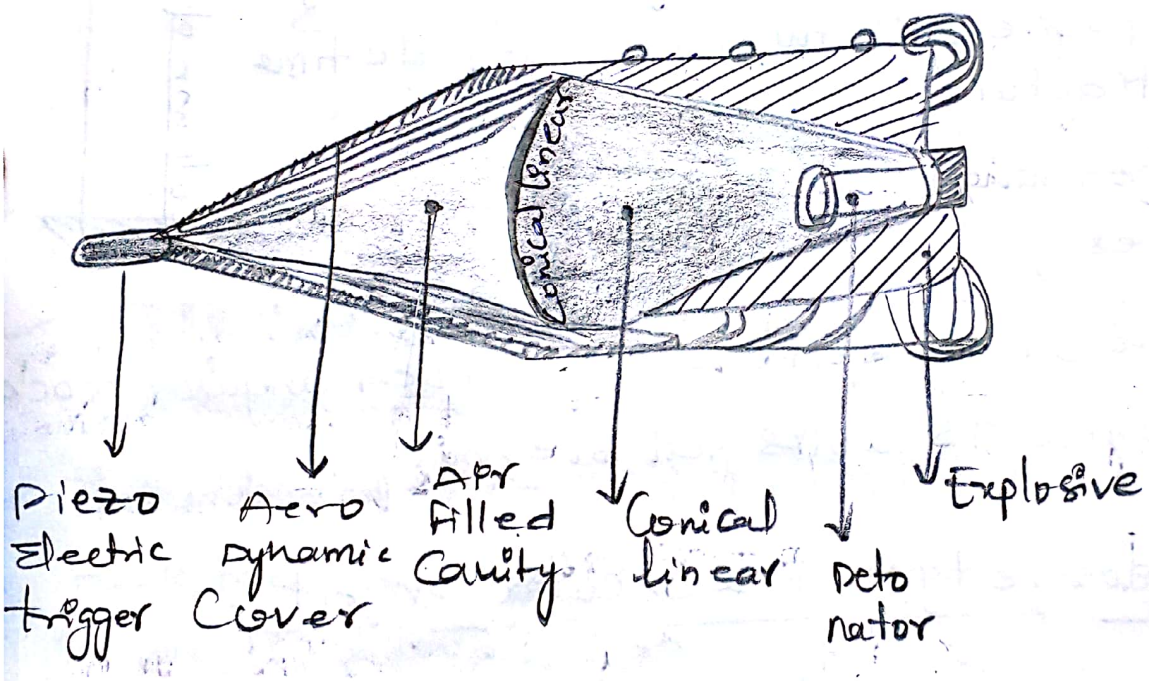
- It confines & stops the gas produced by the Explosive until they have adequate time to fracture and move the ground.
- Stemming length should be 70% of Burden gives good results.
- It is recomended Crushed & sized angular rock fragments works Best stemming.

Explosive type, Hole Inclination ect...

- Every parameters Influences the Rock Breakage If Explosive fails to propagate better shock wave rock will not break.
- If Inclination of the hole is not provided, It will effect on free face, which Inversely affects the Rock breakage mechanism.

The shaped charge Concept :

- A cylinder of explosive with a hollow cavity in one end and a detonator at the opposite end is known as the hollow charge
- The Hollow cavity, which may assume almost geometric shape such as a hemisphere, a cone or the like, causes the gaseous products formed from the initiation of the explosive at the end cylinder opposite the hollow cavity to focus the energy of the detonation products.



- The focusing of the detonation products creates a intense localized force
- This concentrated force, when directed against a metal plate, is capable of creating a much deeper cavity than a cylinder of explosive without hollow cavity, even though more

Explosive is available in the latter case.

✓ This phenomenon is known in the USA with Munroe effect and in the Europe as the von forester or Neumann effect.

✓ If the hollow cavity is lined with the thin layer of the metal, glass, ceramic, or the like, the linear forms a jet when the explosive charge is detonated. Upon the initiation, a spherical wave propagates outward from the point of the initiation.

✓ Then the High pressure shock wave moves at the High velocity, typically around 8 km/sec.

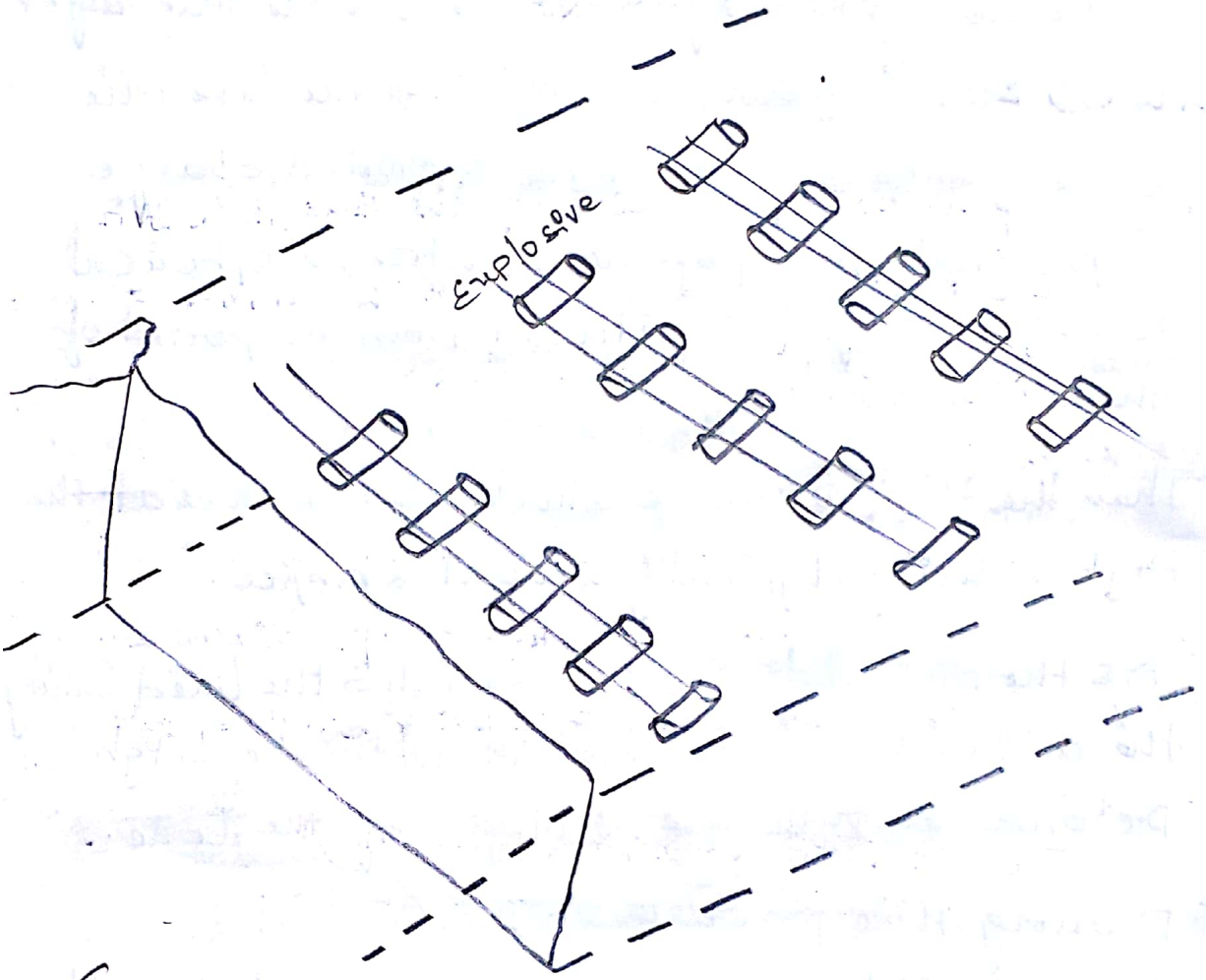
✓ As the detonation wave engulfs the lined cavity the material is accelerated under the High detonation pressure, collapsing the cone.

✓ During this process in the conical linear, the material is driven to very violent distorations over very short time intervals, at the strain rates of the $10^4 - 10^7$/sec.

– The collapse of the conical linear material on the centerlines forces a portion of the linear to flow in the form of the jet where the tip velocity can travel in excess of 10 km/sec.

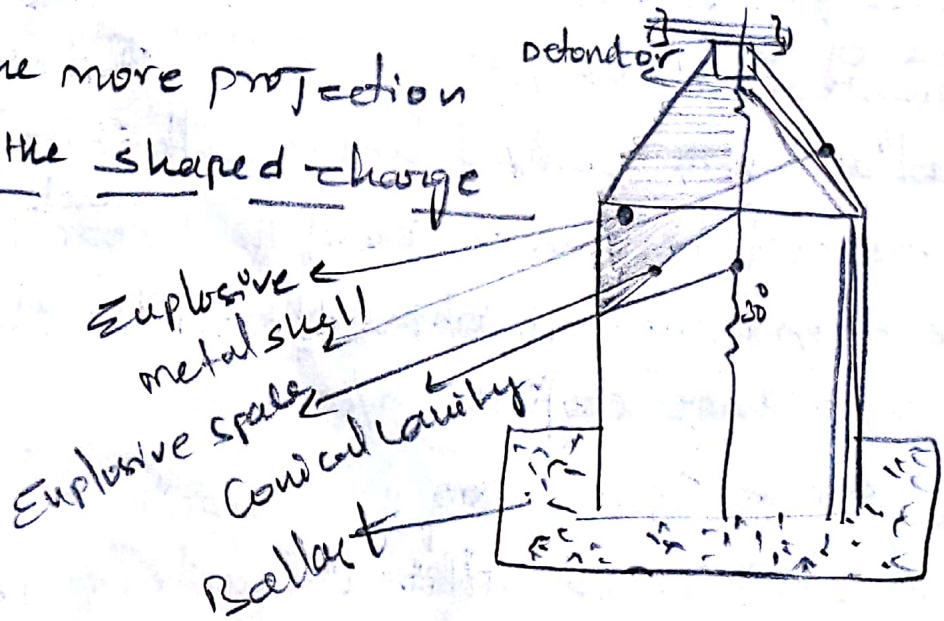
– Because of the presence of the velocity gradient the jet will stretch until it fractures into the column of "jagged" particles.

- It is generally preferred in the underwater Blasting
- The Blasting patterns are generally square firing all the charges instantaneously.



(A general pattern in underwater)

- one more projection of the shaped charge



origin & Importance of Rock Breakage Mechanism :-

Generally rock Breakage will be presented by two phases Earlier. → Phase ①
→ Phase ②

phase ① :

A strong Impact produced by the shock wave up on detonation and linked to the strain Energy during short period of the time.

phase ② :

The gases produced by the detonation behind will come to front into action, a High temperature and pressure, Carry the Bubble Energy which Breaks.

⇒ 8 ← Important Rock Breakage Mechanisms :-

- Crushing of the Rock
- Radial fracturing
- Reflection breakage
- Gas extension fractures
- fracturing by Release of load
- fracturing along boundaries of modulus contrast of the shear fracturing.
- Breakage by the flexion
- fracture by Inflight collisions

All theories Explained by the 'one' mechanism.

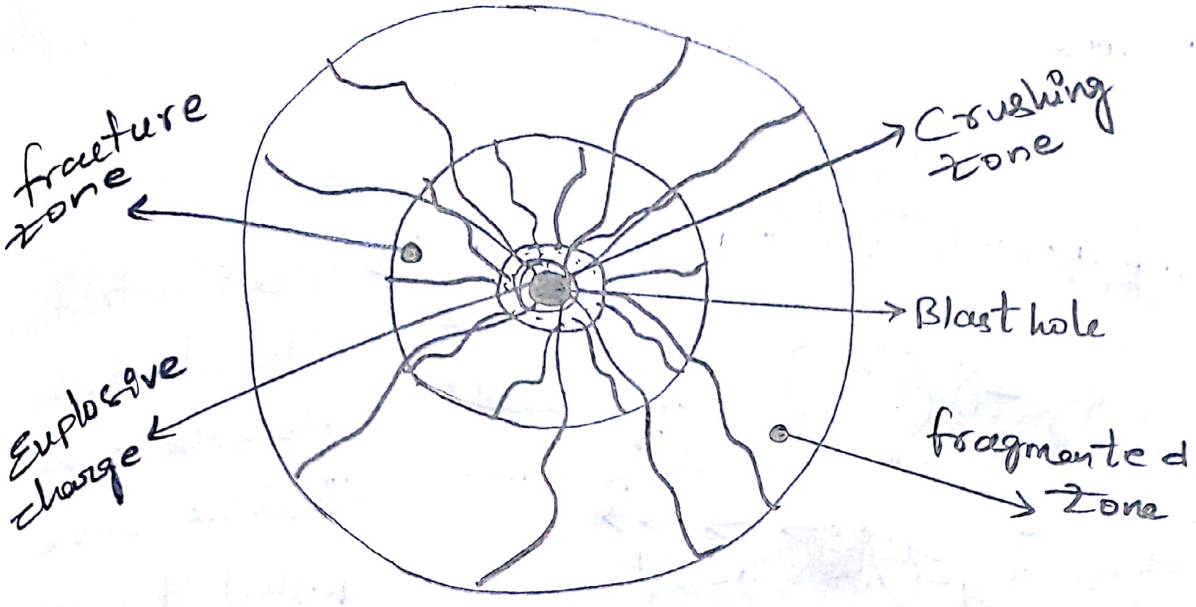
2. Transmission of the strain wave through the Rock mass.

3. Energetic yield of the Blasting

1

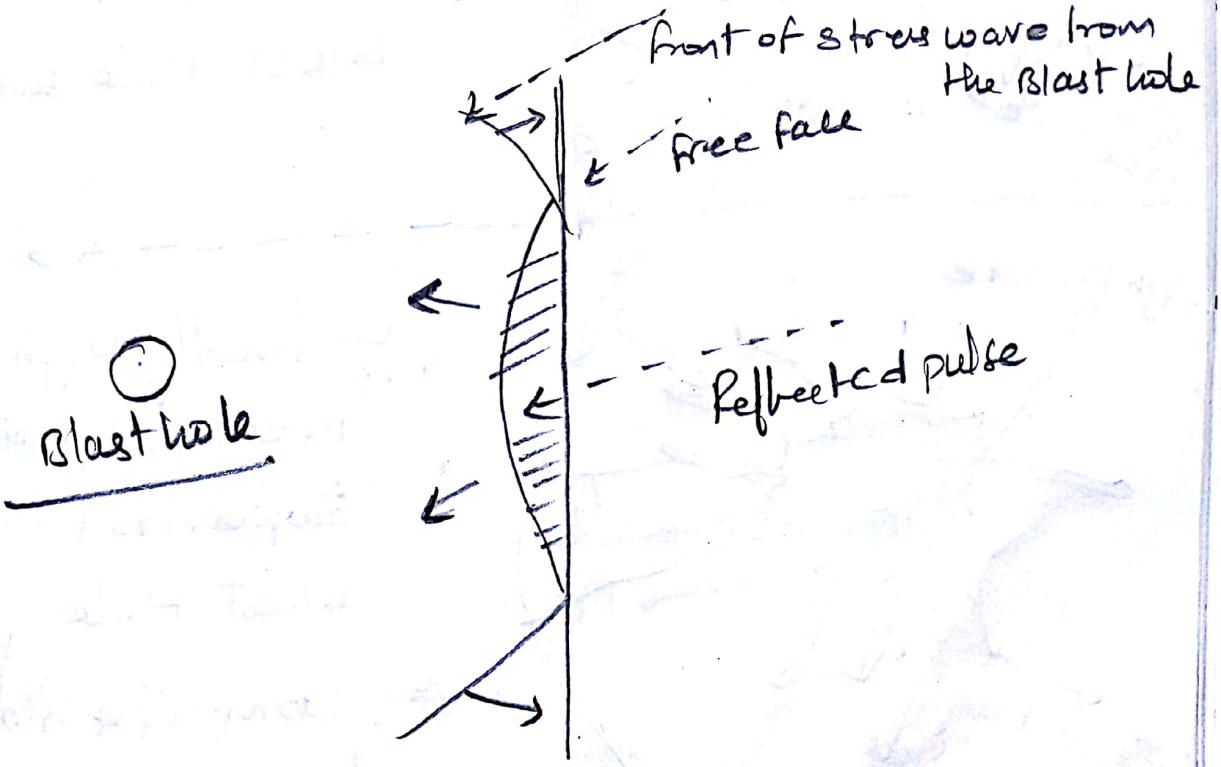
Rock Breaking process by Blasting :

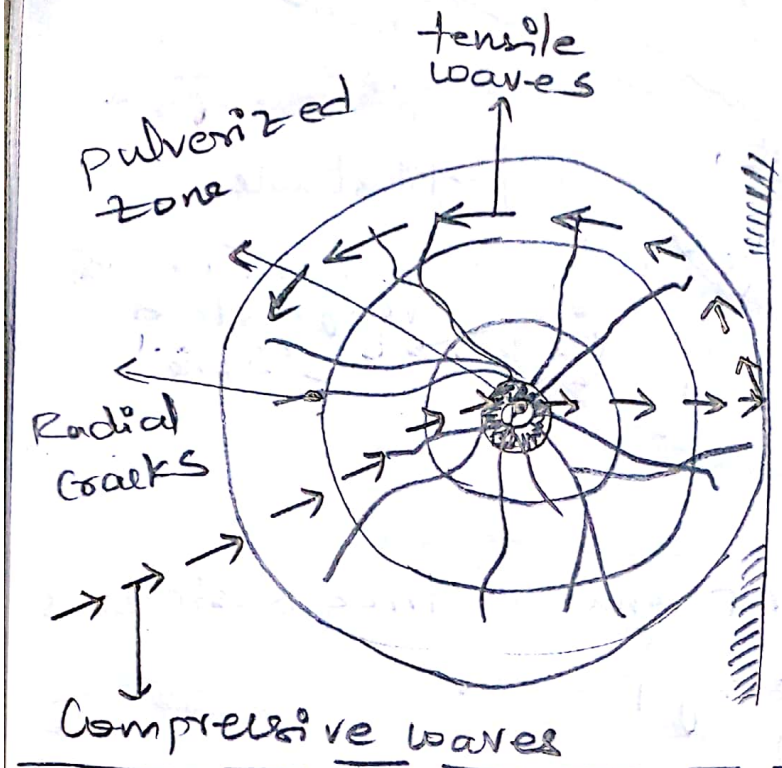
- When the Explosive detonates, hole pressure may be Exceed 20,000 - 100,000 times than the atmospheric pressure.
- This also generates Stress wave that travel with the velocity 5000m/s
- The loading front of the Stress wave is Compressive But it closely followed by the tensile stress responsible for the rock fragmentation.
- A Compressive wave reflects when it reaches a Exposed rock surface and on reflection Becomes a tensile strain pulse.
- Rock Breaks much more Easily in tension than the in Compression and fracture progresses backward from the free surface.
- If the Compression wave doesn't reflect back in tensile wave, fragment will not be obtained properly.



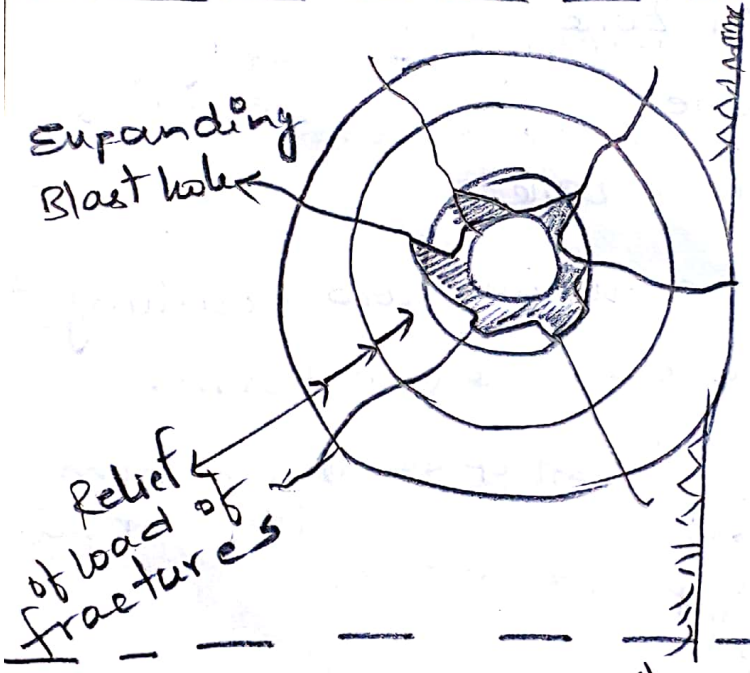
- In the Blast hole after detonation, three Basic zons formed during Blasting process.
  - Pulverized zone
  - Stress zone
  - Radial Crack zone

- The above illustration showing how Crushing, fracture and fragmented zone will form.

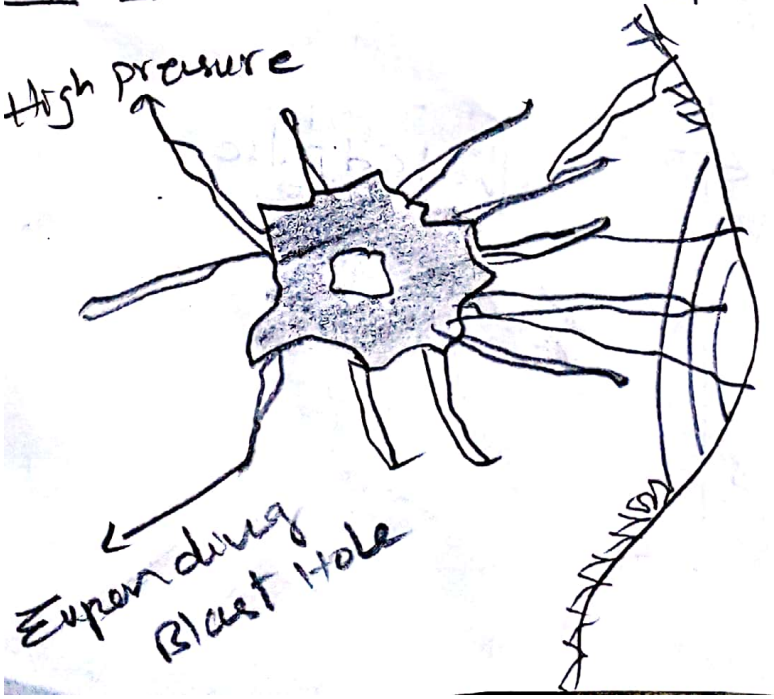




- The illustration Clearly showing How the compressive wave Reflected back in tensile wave
- which causes Rock Breakage



- After tensile wave gets backs
- How the fracturing Develops from the Blast Hole section

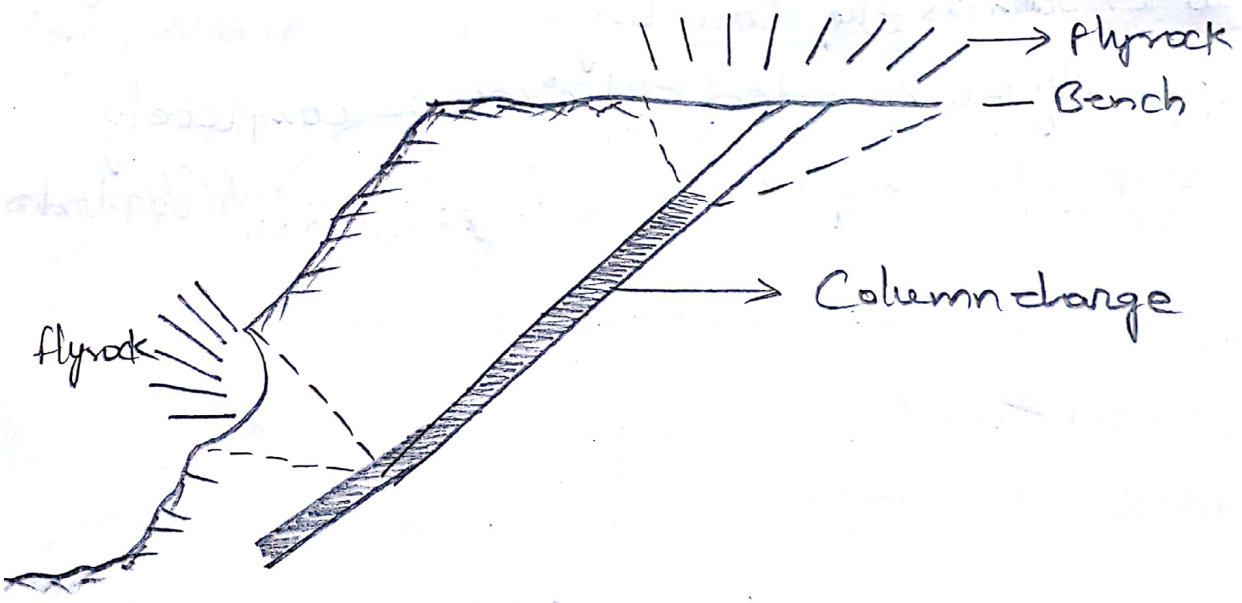


- finally High pressured gases Expands from the Blast Hole
- Complete Blast Hole fractured in last section.

Flyrock :

Flyrocks are uncontrolled and can never be brought to zero. It is a rock that is ejected from the blast site in mining operation.

- The term refers in particular to rock that flies beyond the blast site considered as flyrock.
- particulary in between 1994–2005, about 32 miners were injured by the flyrock.



The illustration showing, that how rock is ejecting from the top of the hole and the sides.

- It is also called rock throw.
- The Explosive which have high bubble Energy (ANFO) will produces more fly rock than the Elevated strain Energy Explosives. Like gelatines.

Main Causes of the fly rock

- > Geological Discontinuities
- > poor Blasting Design
- > Improper charging and firing

Geological Discontinuities :

- ✓ Faults, weakplanes and Cracks
- ✓ Bedding planes, Mudseams and open Joints

Poor Blasting :

- ✓ Drilling, Deviation
- ✓ High spacing and less Burden.

Improper Charging & firing :

- ✓ High specific charge
- ✓ Simultaneous firing
- ✓ presence of loose stones
- ✓ overloaded boreholes
- ✓ Inadequate stemming

Measures :

- ✓ proper charging, stemming and selection of the Explosive is required.
- ✓ By Covering the Entire area by sand bags also fly rock can be Controlled
- ✓ Mainly type of Explosive plays Important role.

Dusts :

It is a general term when the fine particles become entrained in the atmosphere by the turbulent action of the wind by Mechanical disturbance of the fine material in atmosphere.

- The Quantity of dust Emission produced from mining operations can be serious nuisance to the mine workers and population living in the vicinity of mine.
- Dust may be produces due to rock breakage, loading and the transport.
- The Blasting dust cloud may raised to the substantial heights Depending on the Blasting parameters.

Dust Generation :

- Type of rock may one of the reason
- Highly porous rock produce more dust
- Increas in Joints, Dust produceses more
- how density rock will produce, more dust
- clay filled Joints also produce more dust

Control measures :-

By the proper arrangements and combinations of the Blast design parameters also can reduce dust

- ✓ Burden distance & Blast hole spacing
- ✓ stemming height and Effective Subgrade drill
- ✓ charge distribution and Ratio of charge
- ✓ * If Burden is Exceeded, amount of the fines will generate more.
- ✓ If powder factor also Increase the dust more
- ✓ By above provisions, Dust can be minimated

water sprinkling system :-

- The Entire area (Bench top, face and floor) thoroughly sprinkled with water Before charging of the Blast hole.
- The spraying water mixed with the Bentonite or polymer-based Emulsions also can be reduce dispersal of dust used to stabilize solids.

Ground water pollution :

It can be occur both Direct and Indirect as a results of the surface mining.

Direct Result :

- Degradation can occur to ground water situated downhill or down gradient from a surface mine, by flow of contaminated drainage from the mine.
- The mine drainage can be from pits, ponds or from rainfall infiltration and the ground water flow during mining and after reclamation.

Indirect Result :

- Degradation of ground water could result from blasting, which causes a temporary shaking of the rock and results in the new rock fractures near working area of the mine.
- Blasting can also cause old pre-existing rock fractures to become more open or permeable, by loosening mineral debris

17/12/18

Controlled Blasting Techniques :

- > Line Drilling
- > Trim (Cushion Blasting)
- > Smooth (Contour or Perimeter Blasting)
- > Pre-splitting
- > Muffled Blasting
- > Maintaining precise delays

Techniques to Controlle :

- > To Controle over break
- > Reduce ground vibrations
- > Reduce fractures
- > Reduce Noise
- > Reduce dilution / waste of ore.

Line Drilling :

- This system Involves a single row of uncharged holes (closely spaced) along with the neat Excavation line.

- This provides a plane of weakness to which the primary Blast can break.
- It also Causes some of shock waves generated by the Blast to be reflected, which reduces shattering and stressing in the finished wall of the Host rock
- Line Drill holes are generally percussive hammer holes having spaced two to four times the hole Diameter, Drilled along Excavation line.
- The Blast holes directly adjacent to the line Drill holes (Buffer holes) are generally loaded lighter (about 50% of Holes) and are closely spaced (about 50 – 75%) than primary holes.
- This technique gives maximum protection to the host rock to preserve its original strength.
- The Disadvantage of this system is high Drilling Cost Due to closed spacing and results are often unsatisfactory because of poor Holes alignment.

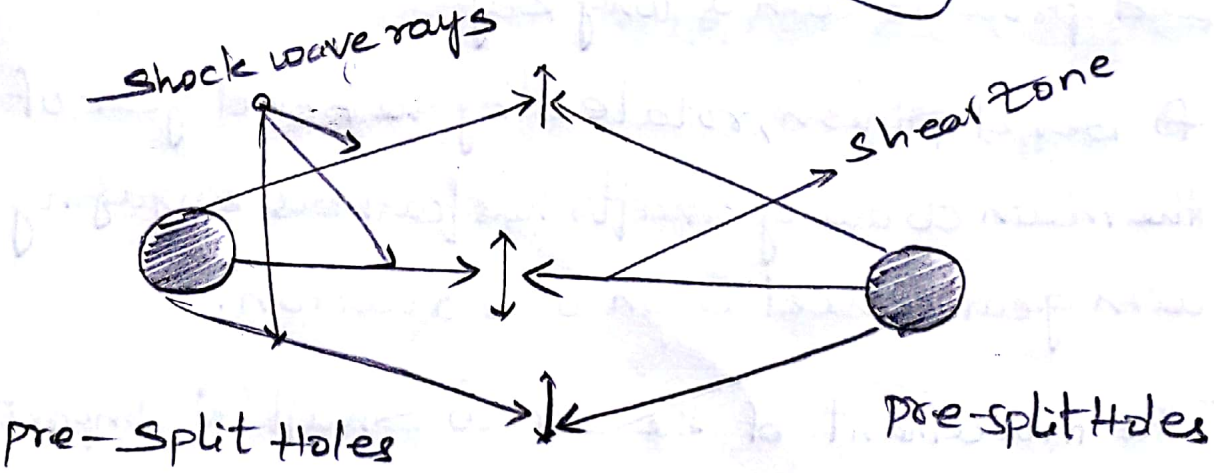
Pre-splitting :

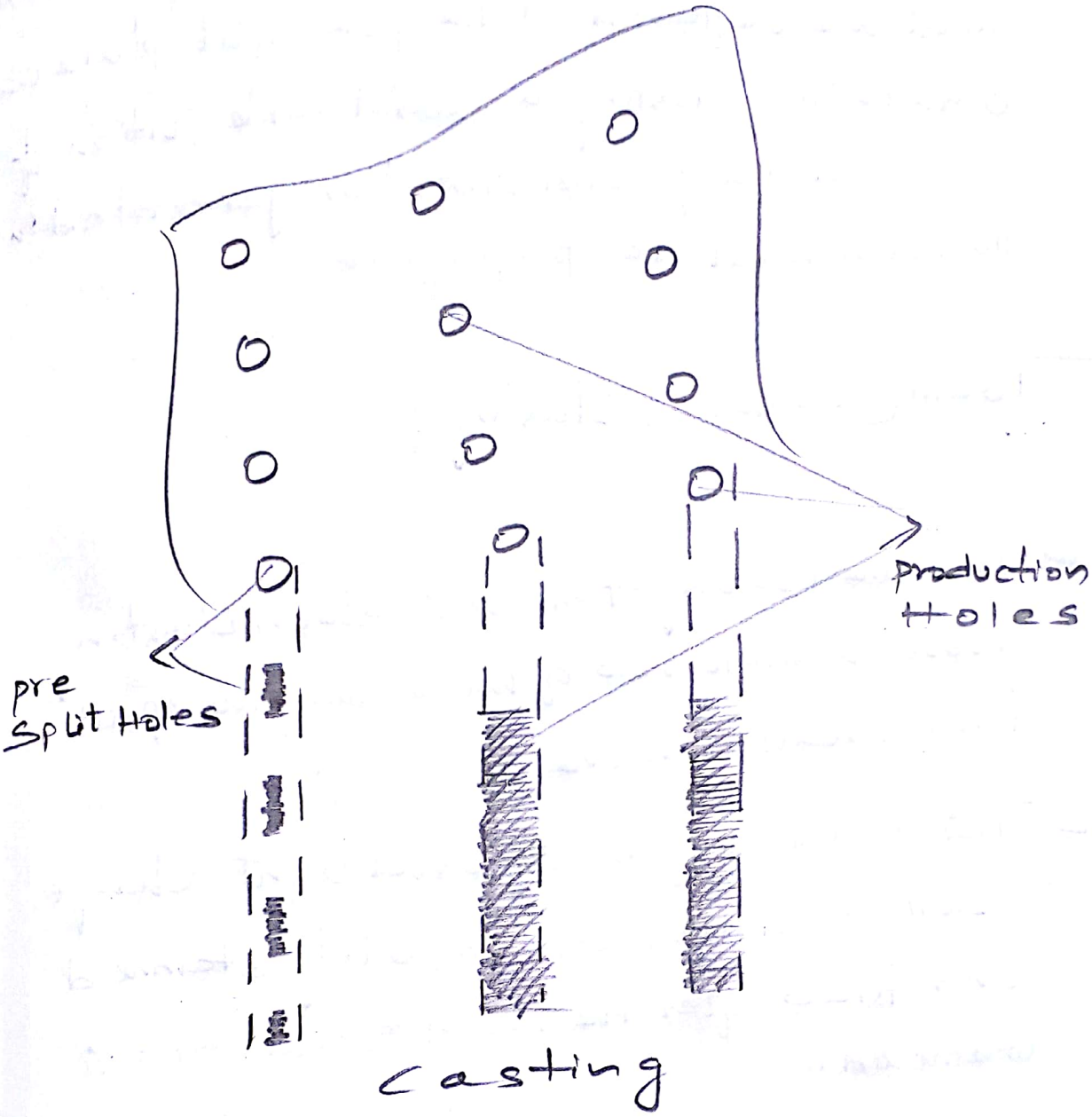
- It is a smooth Blasting method in which cracks for the final contour are created by blasting prior to the drilling of rest of the holes for the blast pattern.

- This is an effective way of restricting back-break and ground vibrations in large open pit, Quarry Blasting

- It helps in isolating Blasting area from the remaining rock mass by creating an artificial Discontinuity along the final designed Excavation line/plane against which subsequent main Blast breaks.

Principle of pre-splitting





- A Row of Holes are drilled at the periphery (three sides) of the main blasting Block at a closer spacing, charged with lesser Quantity of Explosives than the production Blast and the Blasted prior to the main Blast in an Effort to create a fractured line and a reflective Plane at the excavation limit or plane.

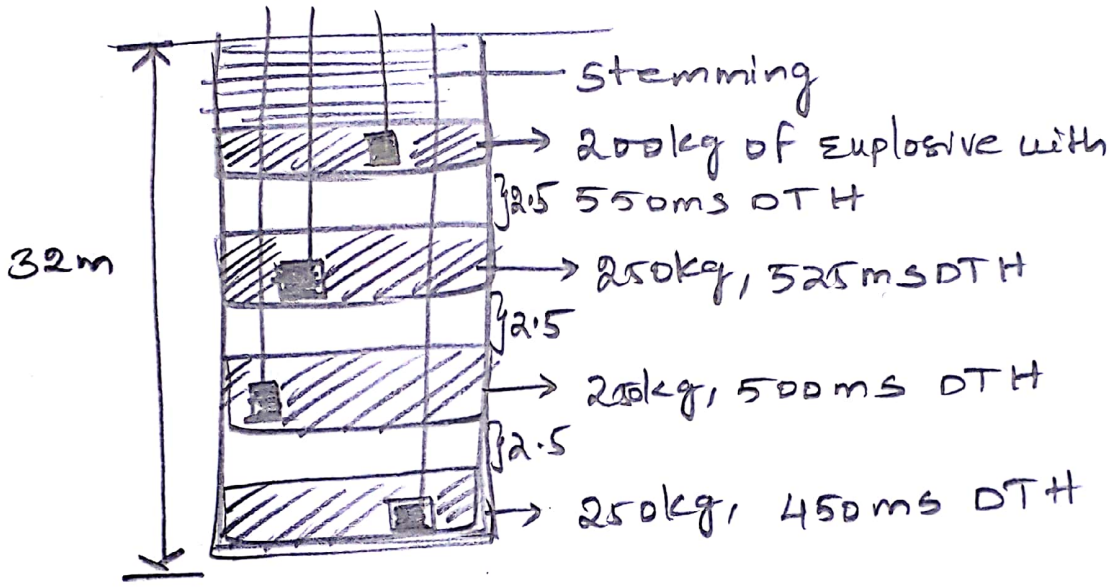
- Some of the shock waves from subsequent main Blast are reflected at the pre-split plane which results in arresting a considerable portion of Blast induced ground vibration generated in the main Blast to propagate.

Trim (Cushion) Blasting :

- Like line drilling trim or Cushion Blasting involves a single row of holes along the specified final Excavation line.
- This technique generally uses light charge, well-distributed, completely stemmed and fired after the main Excavation is removed.
- By firing the trim holes with minimum or no delay between holes, the detonation tend to shear the rock web between holes and give a smooth wall with minimum over break.
- It is better to put trim holes just before removing the final Berm.

Using Milli-Second Delay :-

✓ Delay Blasting (with millisecond) permitts to divide the Shot in to smaller charges, which are detonated in a pre-determined milli-second sequence at specific time intervals.



- Most useful in Quarys, tunnels and O/g Blast
- It Enhances the rock fragmentation.
- charge weight per delay is the most Imp parameter for Controlling Blast induced ground vibration and air-Blast.

Muffle Blasting :-

- Fly rock is another important adverse Impact of Blasting operations, specially, when Conducted in the vicinity of dense human Habitation/ Congested areas.
- Mulling or Covering of Blast Holes properly Before Blasting, is the Common Solution to prevent Fly rock from damaging Human. Habitants and structures.
- Generally, mat or mesh (40mm x 40mm size) made of preferably of locally available steel ropes (5 - 6 mm) are used for mulling purpose. Sand bags weighing 40-50 kg are kept over the mesh at an interval of 3m.
- Efficiency of arresting of flyrock depends mainly on the Quality of mulling System Implemented.

Comprehend(5th Unit)

Topic name:

Date:

What you understand from the topic:

Rate yourself (10):

Rapid test

Comprehensive Scrutinizes

- Scrutinize Area:

- Define Problem?

- Root Cause:

- Control Measures:

- Your Perception:

- Any Enhancements:

PPT Talks

- Topic:
- Subtopic:
- Extracted Core Stuff:
- Pen the Illustrations:
- Mathematical terms:
- What you understand?
- Rate your friend(10):

Journal Interpretations

- Journal name:
- Title:
- Authors names:
- Publishing year:
- Synoptic abstract

- Pen the Illustrations:

- Gross theme:

- What you understand?

Journal Interpretations

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