

Underground mining:-

→ The working of mining is carried out below the ground is known as underground mining.

→ ~~mineral~~ mineral of underground is 2 types
if coal if metal.

→ method of underground is 2 types.

if Board pillar method if longwall method

Underground metal mine:-

mineral:-

→ mineral is a natural occurring homogeneous inorganic substance have in definite chemical composition economically is known as mineral.

ORE:-

→ The mineral which of economically value is known as Ore.

Gangue:-

→ The mineral which is associated with ore and has no economical value is known as Gangue

Ore forming mineral:

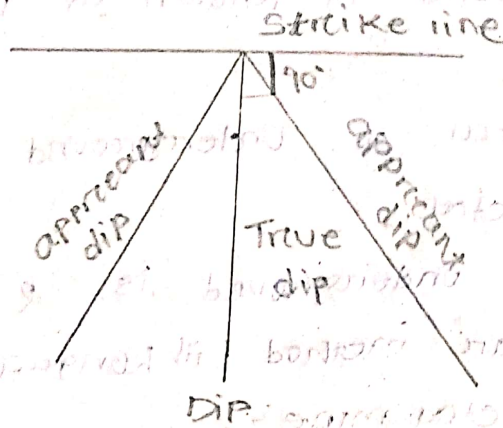
→ The main constituting minerals of the ore body are known as ore forming mineral.

Rock forming mineral:

→ The main constituting mineral of rock is known as rock forming mineral.

DIP:

→ An imaginary line which shows the direction of slope of a plane is known as dip.



→ Angle of inclination with respect to horizontal plane is known as dip.

→ True dip is always 90° .

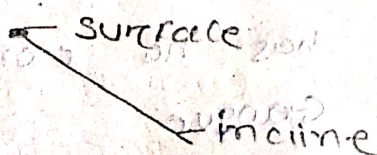
→ Apparent dip: Other than true dip is known as apparent dip.

Adit:

→ It is the horizontal entry of ore body of the hill that is known as Adit.

Incline:

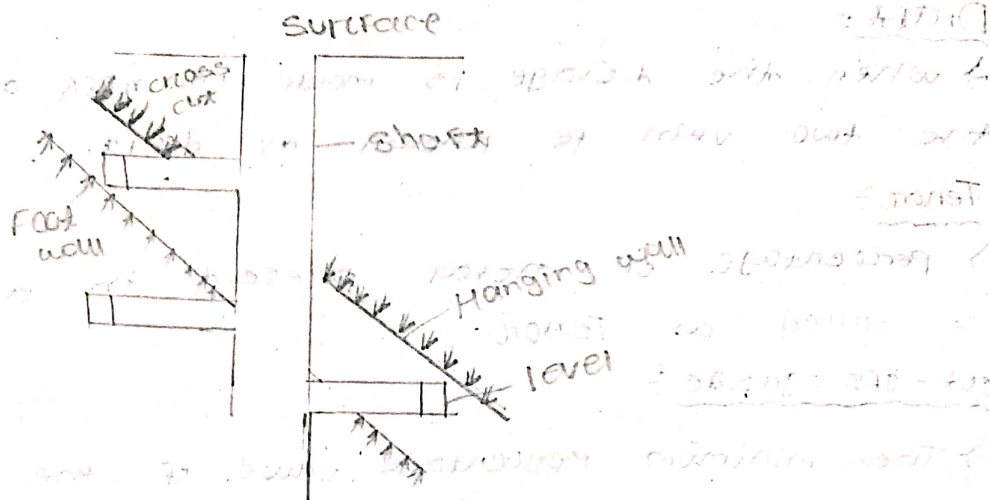
→ It is an incline entry from surface to underground is known as inclined.



→ Displacement of rock is known as fault.

Shaft:

→ It is an entry or exit from surface to underground or underground to surface is known as shaft.



Hanging wall:

→ The strata resting on the ore body is known as hanging wall.

Foot wall:

→ The strata on which ore body is resting is known as foot wall.

cross-cut:

→ It is the horizontal drives from the shaft driven to meet ore body is known as cross cut.

level:

→ when the horizontal drive is driven in the ore body is known as level.

Raise:

→ It is the upward drive driven from the lower main level to meet the upper level is known as raise.

→ The bending of rock strata due to compressive force acting tangentially / horizontally towards a common point from opposite side.

→ It is the downward driftage driven from upper main level to meet the lower level is called winze.

Drift:

→ when the driftage is made in rock across the two vein is known as drift.

Tenor:

→ percentage of metal present in a ore is called as Tenor.

Cut-off grade:

→ The minimum percentage value of the mineral is known as cut-off grade.

Development in underground metal mine:

An underground mine in the early stage require a carefully plan network of shaft, drifts and raise which serves the following purpose:

- ① Enables to know the quantity of mineral and its extent as well as shape and size thickness, nature of the country rock.
- ② It permits prospecting to be carried out from underground working.
- ③ provides access and transportation facilities for men, material & the excavated worked.
- ④ Permits arrangement for drainage of water and ventilation of the
- ⑤ It enables planners to decide open the method of stoping.

The formation of such network of shaft, drift and raises above is known as development of mine.

① shaft should be on the footwall side.

② Transport of material:-

working faces, production points should be on downward direction to have a advantage of gravity.

③ stoping should be done in a refracting manner.

④ ventilation, the direction should be opposite to gravity ~~the~~ i.e from lower working to the upper working.

⑤ support should be if permanent in nature in places to be supported for underground duration.

Stope:-

An underground area generally represented by a block of ore from which ore has been extracted as a fixed operation.

Raising

Raising:

- > movement of forward direction with development is known as Raising.
- > It is also used as connect one underground working to another underground working.

Method of Raising:

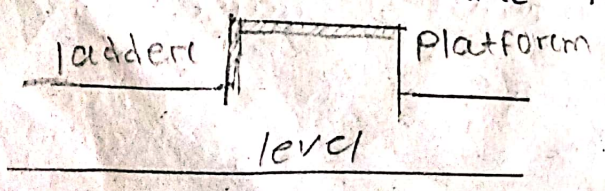
- 1) Open Raising method
- 2) 2-3 compartment method
- 3) Raising with jora raise lift.
- 4) Atimark raise climber
- 5) Raising by the hole drilling method
- 6) raise borer

Problem of Raising:

- > Fumes of a face
- > method is unsafe and inconvenient
- > ventilation poor
- > Before blasting platform and ladders and acc to be removed
- > The method is very slow and productivity is less.

(1) Open Raising method:

- > This method is simple and most common method which is adopted mostly underground metal mine.
- > The workers stand on a platform which is made in timber planks supported on stall or form bars fitted in the footwall side.



→ The clamps used for supporting the platform are made in standard length cut off by raise.

→ The drilling of holes for blasting is by jack hammer drill and generally follows wedge cut pattern and burncut pattern. Holes are 32mm diameter and 1.5m dip.

→ Before each round of blasting the platform is disassembled in accordance after blasting compressed ^{air} is forced to the working face by compressed air pipe to receive fumes of blasting and for ventilation.

→ To the face is by ladder made of woods or steel rope.

Cycle involve:-

1) Inspection of a face.

2) If the face is not safe then dressing is carried out.

3) Erection of ~~problem~~ platform or scaffold.

4) Drilling and charging of holes.

5) Remove scaffold & also part of ladder.

6) Blasting.

7) clearing of fumes.

8) Repeat from last to 1st.

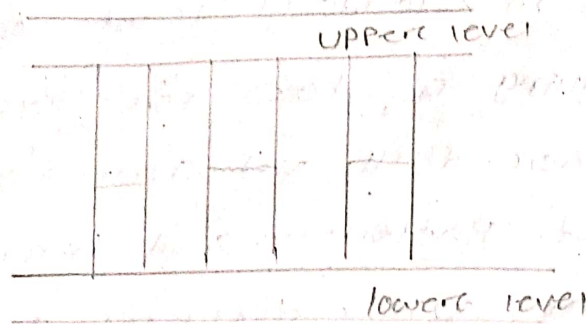
Disadvantages:-

→ Lack of ventilation.

→ Platform holes require proper alignment.

→ Low of efficiency when the raise go wedge as the workers have to frequently go up down the ladder.

Long hole drilling method:

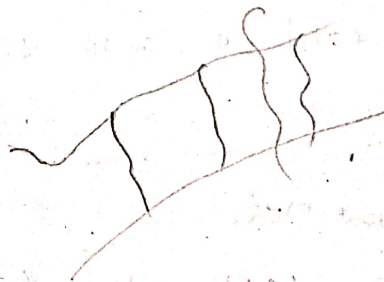


→ In this method all the drilling, loading and blasting operation are performed horizontally working and there is no need for the to present at the face.

→ In order to put up a raise between the two levels by parallel blasting holes are drilled from bottom in upward direction upon it's full length.

→ The holes are than fired portion wise, either or in succession.

→ The length of the section depends by the properties of the rock usually raising from 1.5-6m or even qm.



→ The bottom part of the blast hole is filled with PUGS from below and explosive charges are lower down into the holes using and than the hole is close from the top with stemming material.

→ The charges are fired by ^{or} detonating fuse or by electricity.

→ The method used only in ground nearby for excavating cut out raise in stoping.

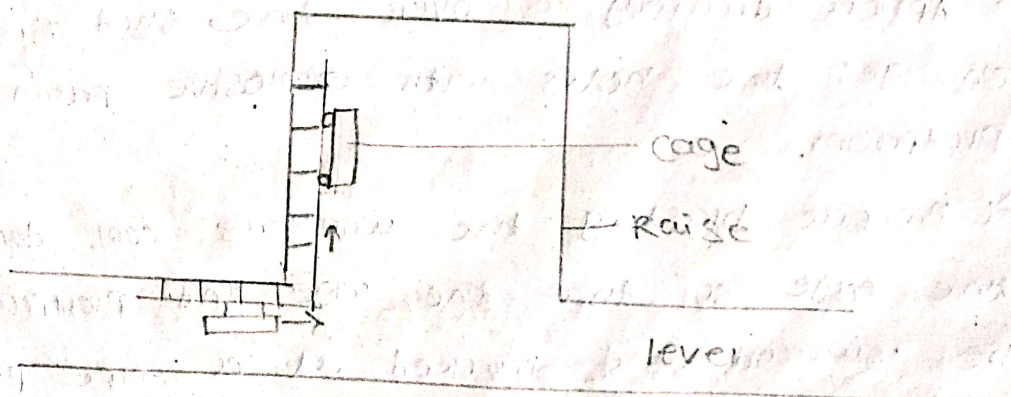
Advantages:

- Removal of ladder or scaffold.
- There is no form work.
- Method is safer than other.
- It secure lowest cost.
- High drive speed.

Aimark raise climber:

→ This method of drive long raise with the help of a machine called aimark raise climber was introduced in 1957. In India it was introduced 1st time Jajugada Uranaceous mine in 1972.

→ The method is based on rock and pinion drive with a guide rail fitted to the hanging wall and drilling blasting are carried out from this platform.



Treatment:-

- A is secured to the wall of the raise by rock belt.
- On this roll a cage travels by means of a look & pin arrangement.
- A reel reel with air hose to provide compressed air to the causing travel of the cage.
- The rock belts which are used for bolting the guide rail are of explosive shock type and recoverable spacers are provided to recover the length between the rock belt and guide-rail.
- pipes are for compressed air and water.

working operation:-

- At the face of the raise, the drilling drudge the short holes with jack hammer standing on the platform and well protected canopy. Two Jack hammer can be operated at a time.
- After drilling is over, the shot firer charges the holes with explosive from the platform.
 - Before blasting, the workers cool down in the cage, so that the cage and platform can be lowered and parked at a safe place, away from the damage by blasted rock.

→ After blasting water and air are the guide to clean away the fumes vertically the face.

→ The workers than up to the face and guide roof in than extended.

→ The cage and platform can be placed close to the face for further operation of drilling-blasting.

Operation cycle:

<u>Operation</u>	<u>Time</u>
1) Climb up the raise	5
2) Dressing down roof & side	15
3) Removing blasting header & extend guide roof	20
4) Blasting and hook up operation	30
5) Drill 2-m deep	90
6) Remove Drill header	10

BREAST STOPPING

→ when the holes are drilled in front of face such holes are known as breast hole

→ when the stope is extracted by breast hole than this method is known as breast stopping method.

→ In this method the drivage are horizontal drivage

→ The breast stopping method are also classified into

i) Hanging bone method

ii) Putwall cross and box cut method

iii) Board and pillar method

iv) scattered hole method

v) Breast hole with chute method

vi) Breast stope with wide orebody

i) Hanging Bone method:-

Suitable zone:-

→ Inclination of orebody is 0° to 30°

→ strong orebody that can stand the pressure of strata.

→ The hangwall and footwall both are strong that can be stand without any support.

→ The thin orebody. Thickness of orebody is not exceeding 4.5 m

ii) Footwall and Box cut method:-

Suitable zone:-

→ orebody with inclination is more than 10° not exceeding 30° to 35°

→ It is work on a orebody upto 4.5 m

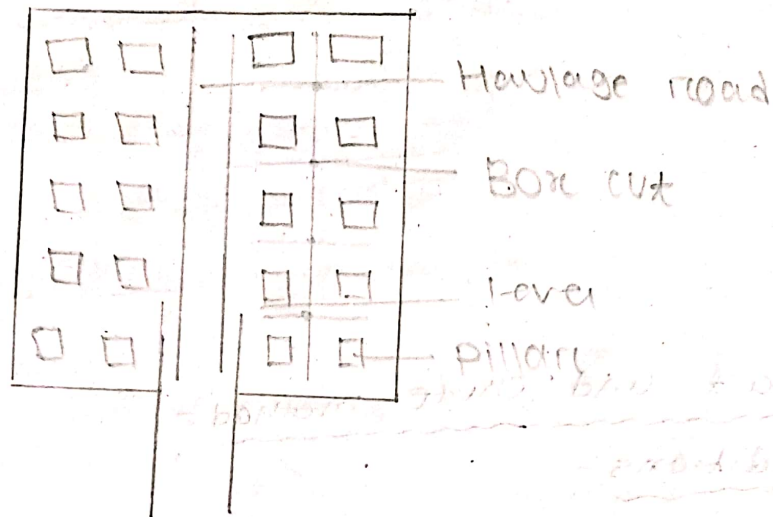
→ The orebody is recovered to strong method.

→ poor orebody are and less costly mineral are worked by this method.

Development:-

→ To development of the orebody to boxcut are driven at 100m-200m distance.

→ The orebody is developed by level driven from boxcut this levels are inter connected are interval for easy travelling.



Board and pillar method:-

condition:-

→ when the orebody is strong.

→ Hanging wall and foot wall is strong.

→ The orebody thickness is not more than 4.5m

→ Inclination of orebody is 0° to 30°

→ It is also poorly mineral and less costly.

Scattered hole method:-

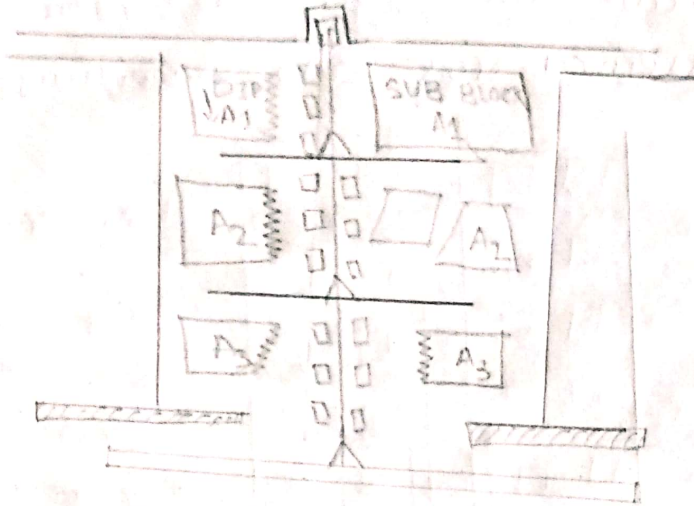
condition:-

→ condition for the selection of this method are same as Hanging bone method.

→ when the deposit is more than upto 30° .

Development:-

- The development is same as hanging bone method.
- The level interval of this method is kept less.
- The level interval between 150m - 300m.



Breast and chute method:-

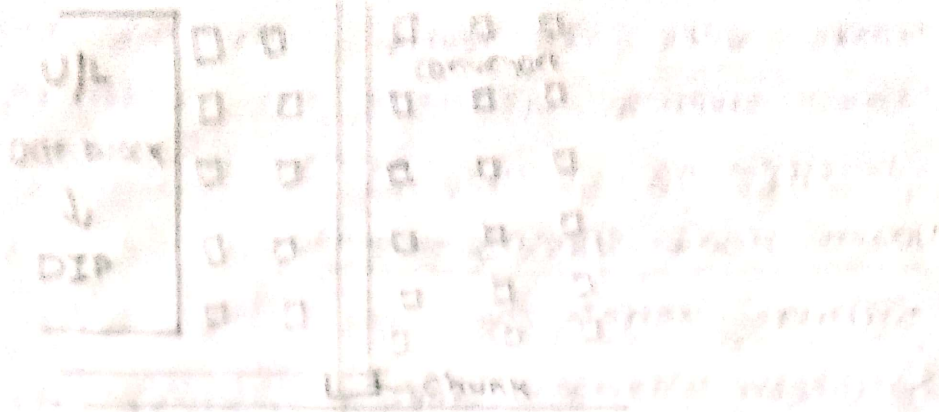
conditions:-

- Thin orebody
- seam thickness upto 4-5 m
- inclination between 10° - 30°
- strong hanging wall and footwall.
- It should stand supported

Development:-

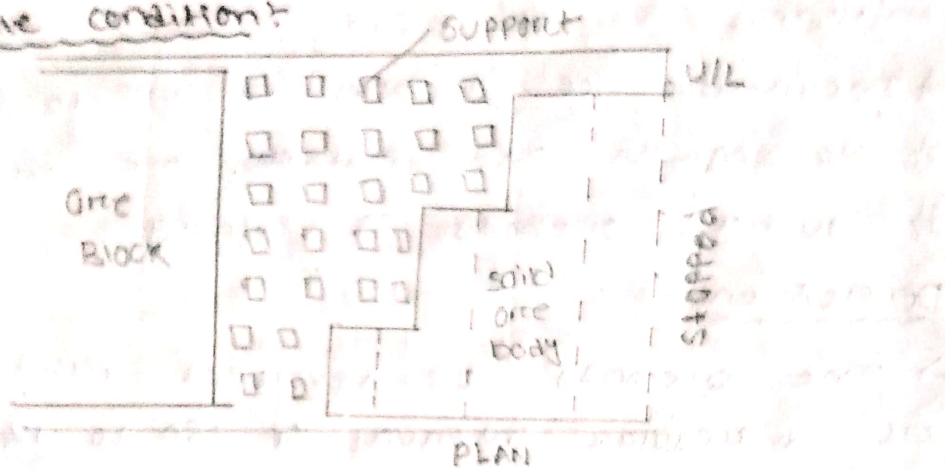
- In this method orebody is developed by levels and driven at regular intervals of 60 - 200m.
- These level are inter connected at regular intervals.
- Thus forming OR ore block are square

STOPPED



Break slope with wide orebody:

Suitable condition:



- > The orebody thickness is more than 4.5m
- > Inclination of the orebody is low deep 0° to 30°
- > The orebody is very strong.
- > wall's are also strong.

Development:

- > The orebody is flat it may be low inclination 0° to 30°
- > the ~~orebody~~ orebody is developed on the principle of Hauling bone method, or Board and Pillar method.
- > The level interval's are kept 30 to 60 m, and level are reg connected at regular interval of 60 to 90 m. of one block.

→ when the development is complete at least upto 2 levels upto the boundary the stoping operation is undertaken development made along the foot wall.

Under Hand Stopping method:-

suitable zone:-

→ Under hand stopping method for thin orebody is preferred under following conditions
a) It is suitable for thin orebody and the thickness is ~~not~~ 1.5 m

b) Inclination of orebody is 45° to 85° .

c) Hanging wall and footwall are both strong.

d) Overall orebody is strong

Development:-

→ The orebody is developed from the shaft or at regular interval of 60 to 150 m in the direction of orebody.

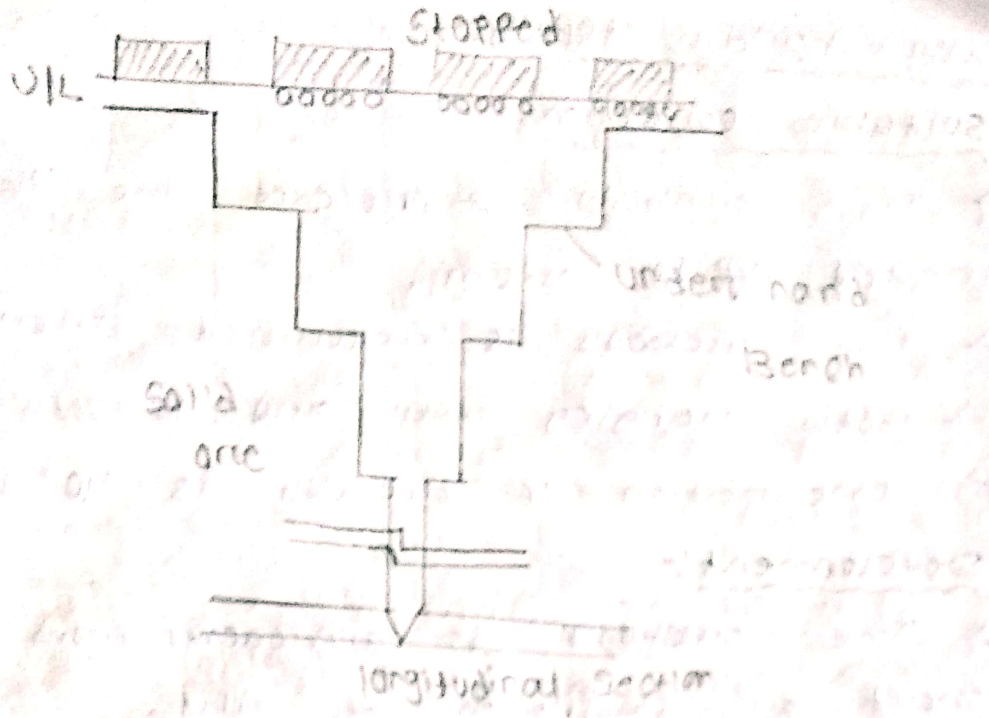
→ when the crosscut touches to the orebody level are developed at suchering the orebody at horizon cross cut

→ In some cases the companion levels are driven parallel to orebody.

→ The presence of orebody is checked by bore hole and at regular interval.

→ The levels are connected by raise or winzes of 60 to 150 m. This connection of

→ This level is made for proper ventilation supply material for safe working of faces and transport of men and material.



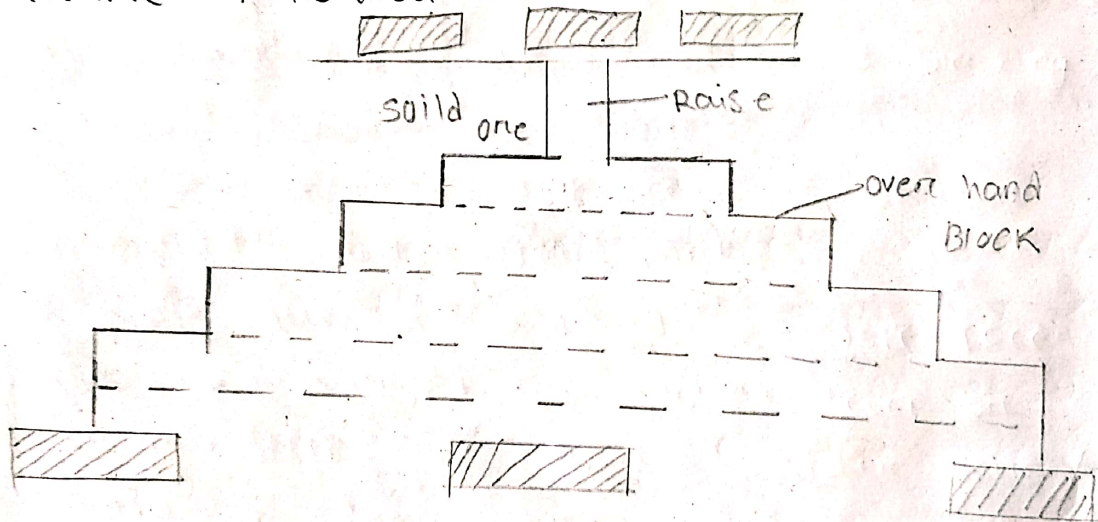
Over hand stoping:-

Suitable condition:-

- This orebody is preferred the thickness selected up to 4.5m.
- The orebody is required strong.
- Both hanging wall and footwall strong.
- Inclination of orebody is 40° to 90° .

Development:-

- The orebody is approached from the shaft or ~~inclination~~ ^{Inclination} or Adit.
- This are located generally away from orebody.
- The interway is kept 60m - 125m



longitudinal section

- when cross cut touch to the orebody, the orebody is developed by driven the levels or companion levels at their horizon.

- This levels are inter connected at regular interway by raise and winzes.

- The raises and winzes are connecting to the lower level to upper level this are used for ventilation purpose, travelling of workers, supply of materials for safe work.

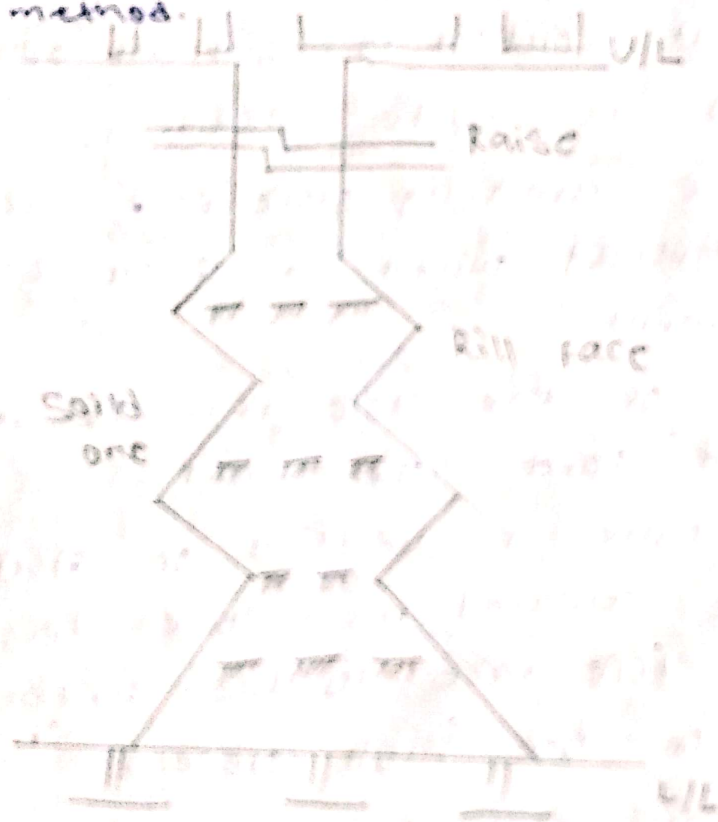
Flat back overhand stope:-

Suitable condition:-

- Thin orebody thickness not more than 4.5m
- High inclination from 40° to 85°
- Strong orebody knot can stand the weight is used
- Strong wall which can stand pressure with out any support

Development:-

- It is same as describe from overhand stope method.



Cut - Fill method

Suitable conditions

→ This method is used for thick and extra thick orebody.

→ The working is same as described in case of wide orebody.

Development

→ After each operation of blasting the broken ore is removed the compartment of that portion is vertical advanced and it is waste filled.

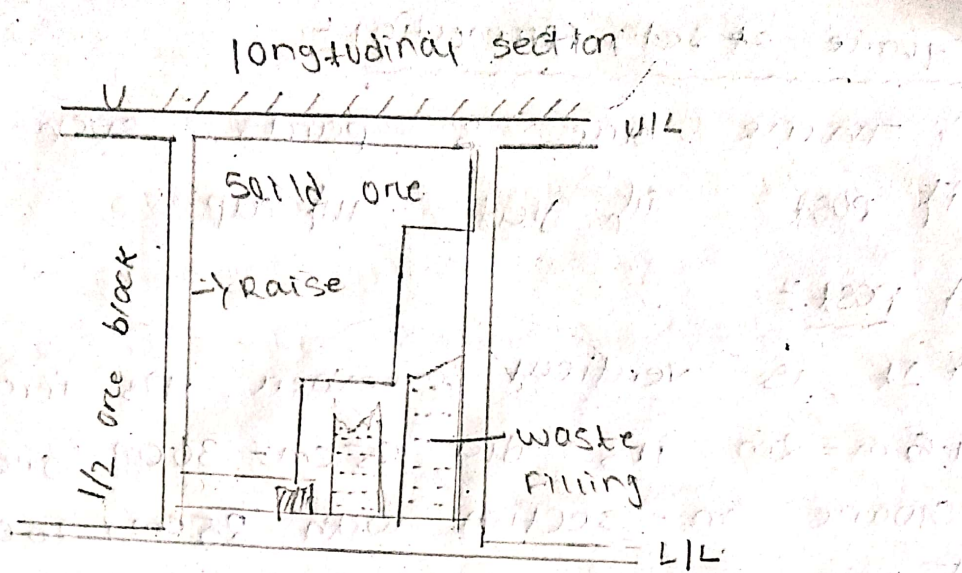
→ As the completely slope face each heightent for completely width in 2 or 3 blasting compartment.

→ each of the slope face is similar advanced part after part.

→ The cycle of working of slope face will be carried from lower level or lower slope face to the center raise/winze on the high slope.

→ In this method the expose of gas gap between the slope face and the filling is tried to maintain constant at 1.5m - 2m always.

→ In this method the addition artificial support can be given to the slope face by props and logs.



Timbered stop:

- It is one of the important method in stoping method.
- The timber sets are used in stoped area to extent the support to weak wall.
- The timber shape may be square timber shaped the square timber as many variation of their joint formation but it consist of 3 measure parts :-
 - 1. post
 - 2. Grit
 - 3. cap
- one post is vertical member, Grit is horizontal member resting on two post in longitudinal direction of working.
- cap is a second horizontal member resting on two posts in transverse direction.
- At one point there will be joint of cap and grit sets can be extended in longitudinal direction, transverse direction and also a vertical direction.

Square sets formation :-

→ There are 3 parts. such as -
if post if grit if cap

if post :-

→ It is vertical member its length is 1.5m - 2m its dia 25cm - 30cm one generally square in section with 25cm x 25cm sides.

→ At either it has block projection of size 10cm x 10cm sides in the center with 10cm height.

Grit :-

→ It is a horizontal member

→ Its length is 1.5m - 2m its section is 25cm width 20cm thickness. It has project cut of size 10cm x 20cm in the center.

At the project cut of the both ends of this horizontal members inclined cuts are used and more projection are cut.

cap :-

→ It is a second horizontal member of the square shaped and its length is 1.5m - 2m and its either end are flat cut section

→ this is commonly used because it is very simple but when the grit has more projection the cap also given cut to fit in the projection.

→ when the cross-cut is reached below the orebody the level is driven on either side of orebody.

→ The existence of the orebody is checked by boreholes at regular intervals.

square-shaped timbered slope:

Suitable condition:

→ This method is used for thick and extra thick orebody the minimum thickness of orebody worked by this method is equal to length of a square shaped.

→ Inclination suitable is $40^{\circ} - 35^{\circ}$

→ The orebody is strong and stand its own weight.

→ The hanging wall and footwall are weak and there required support.

→ The orebody should be of costly mineral.

→ The deposit required regular not suitable small pocket deposits.

development:

→ The orebody is approached through shaft or inclined.

→ The orebody is developed by driving the cross cut and levels at regular intervals this levels are developed at 20-60m interval to connected by raise/winner at regular interval 30-60m.

→ Thus the oreblock are formed between the levels.

→ The development worked of the boundary of mine.

→ when the orebody is blocked upto and atleast by two adjacent levels the stopping operation is under taken from the boundary of the working.

shrinkage stoping:

→ This method used for thin orebody or thick orebody the entire thick orebody can be also worked and modification.

* It is suitable for strong orebody that can stand the pressure and its own weight.

→ The strong wall ore recovered so that can stand stricter pressure and can remain on supported.

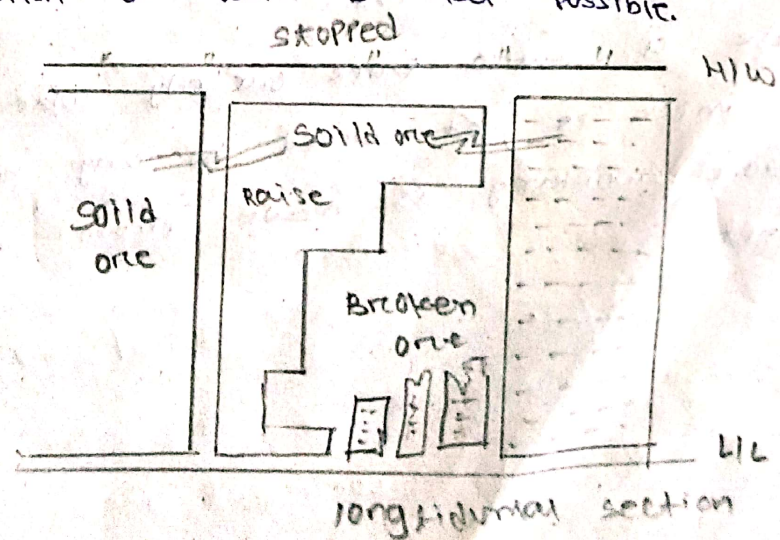
→ The grade of the orebody is high as there is possibility of dilution of orebody during in the final withdrawal of broken ore in stope.

→ The inclination recovered is more than 40-55° in vertical.

Development:

→ The shrinkage in an overhead stope method the broken ore is used as support to walls the broken ore occupies 30-40% more space thus 30-40% ore is withdrawn during the stope working rest of broken ore is left in the stope.

→ This gives temporary support to walls in this method there is complete extraction of narrow vein in case of wide orebody vein the completely extraction of vein is not possible.



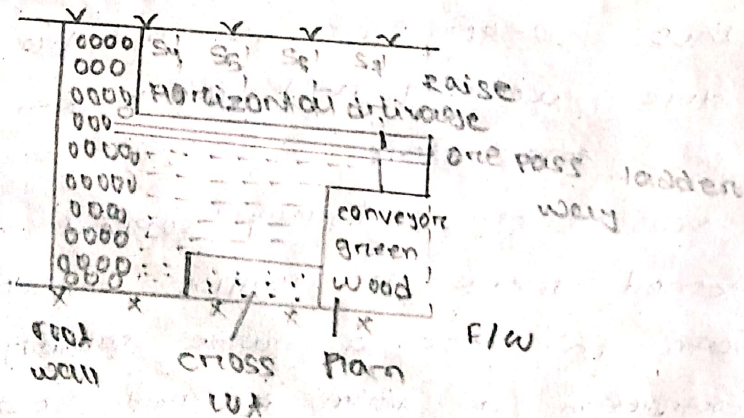
Sub-Level caving:

Suitable condition:

- This method is suitable for thick and extra thick orebody.
- when the orebody is weak and moderately shaft.
- when the hanging wall and foot wall are weak.
- the orebody is horizontal or as moderate slope.
- when the forest is approach for regular support of green wood.

Development:

- The preferation of slope is similar as in case of top-slicing method.
- the main level interval in this case of 20-60 cm.
- the oreworked in this method stronger as compared to the top-slicing and timber uses.



- In case of extra thick orebody sublevel is provided which is not served by any haulage to shaft. the slope working is made from boundary

Face Mechanization

SDL:

SDL → Side discharge loader

→ It is a popular coal loading machine of underground mines which can upload coal to the right or left of the coal.

→ SDL takes blasted coal to the face with bucket cut front of the machine and dump coal on to chain conveyor.

→ It is generally chain mounted.

→ It can be working in gradient upto 1 in 4.

→ Height of the machine overy canopy 2.1 m special model. for working seam as thin as 1.3 m.

→ The machine is powered by 550v electric motor on all movement at the bucket are done by hydraulic power.

→ The bucket capacity into various from 0.8 m³, 1 m³, 1.5 m³. SDL of buckets capacity 4 m³ for coal (0.6 m³ for stone) are be most common.

→ SDL are used both development and de-pillaring.

Safety features:-

→ Parking break / service break

→ Deadman switch

→ Emergency stop

→ AVA (Audio visual alarm)

→ low oil level and high power temperature cut-off switch

→ Front and rear light

→ canopy over operated switch

LHD

→ LHD - load haul dumper

→ LHD is a tyre mounted loading machine which takes blasted coal from the face in its bucket, transport and dumps on the belt conveyor or chain conveyor.

→ It runs faster than the SDL because it is tyre mounted.

→ It speeds upto 4 km/h

→ LHD can work on gradient upto 1 in 7 where floor is dry and not weak.

→ Its bucket discharge is of types 1) Tilting front discharge 2) pusher front discharge

3) Tilting side discharge 4) chain side discharge

→ LHD is made in 2 parts which is connected by the flexible joint and can turn upto 100°

→ LHD can work on seam upto 2.4 km track.

→ It has various bucket capacity 1.5 m³, 2.7 m³

At 1.5 m³ LHD is powered by 50 HP / 550 v 4P.

Safety features:

→ same as the SDL safety features

UDM:

→ UDM - universal drill machine

→ It has crawler mounted electro hydraulic machine

→ It can drill blast hole in the face and also hole from roof bolting.

→ UDM is provided with a 22 kW / 550 v flame proof motor

→ movement of drill boom and feed with hydraulic pushes.

→ The machine can drill 38mm hole upto 1.8 m.

→ It can worked gradient upto 1 in 4
in seam height upto 3.5m.

→ The machine is 1.6m height, 4.6m long and 1m wide with a travelling speed into 2.2 km/h

Safety features:

→ various break on track motor

→ emergency stop

→ AVA

→ Deadman for switch

→ light

Shuttle cart:

→ It receive coal from continuous miner and unloads it onto district belt conveyor.

→ It is feed with a long travelling cable boom.

→ It is tyre mounted it is worked in gradient upto 1 in 12 for the floor is hard and dry.

→ FIMCO ELECON is manufactured of shuttle cart of 8tn capacity.

→ It takes only a minute to load or unload when it loaded run at speed upto 5km/h

→ It is fitted with flame lap proof motor

→ use of 15m³ capacity diesel shuttle cart.

Types of Break

→ There are mainly 3 types of break normally HEMM (Heavy Earth mover machine)

- (i) Service break
- (ii) Parking break
- (iii) Retarder break

(1) Service Break:-

→ on operation of break on dumper running at 30 km/h on a level road / transporting road.
→ It's should be stop dead with in 21m.

(2) Parking Break :-

→ should be able to hold a loader dumper on a gradient of 15° for atleast 10 min.

(3) Retarder Break:-

→ functioning testing area in workshops is kept fenced. once in 15 days break

Rope shover:-

→ shover is most commonly used in excavating equipment in opencast mines.

→ This is normally chain mounted machines stand on bench floor and lifts soft soil or blasted coal or OB.

various parts:-

- (i) Bucket
- (ii) dipper stick
- (iii) boom
- (iv) machine house
- (v) crawler chainches

→ Bucket of Shover in size of india 4-6, 8, 10 and 20 m³ electric shover are used in India.



Hydraulic shovel:- Drive Tumbler Side frame

→ The hydraulic shovel also run chain mounted.

→ which is capable / it so swarming through 360°

Backhole shovel:-

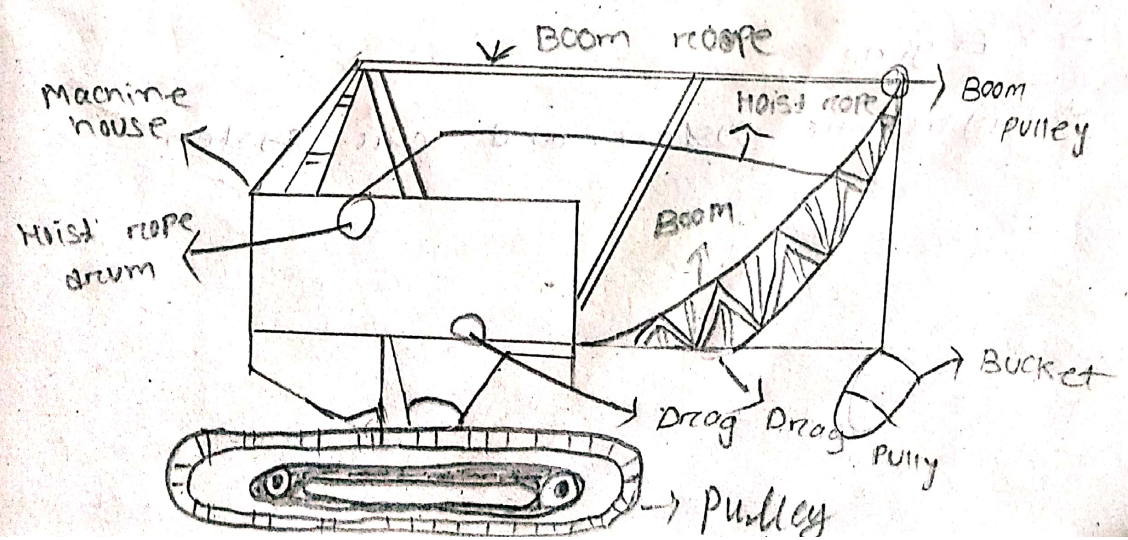
→ Back hole shovel is a disc operated chain mounted machine.

→ Backhole capacity 1.5 to 3.5 m³ Used for specially proposed in india.

Dragline:-

→ It is a long boom crane line machine which leave earth, soft rock or blasted OB from the face.

- Main parts:-
- (i) Bucket
 - (ii) Boom / AFRAME
 - (iii) machine house
 - (iv) chain chassies / walking pads



DUMPER:

→ Dumpers are used in almost all open cast mines. They are loaded by rope shovel, hydraulic shovel, backhoe or re loaders to transport OB/coal.

→ Dumpers used in open cast mines are heavy duty trucks which,

* can withstand shocks of material loaded duty truck which,

* can unload the material fast.

→ size of dumper is chosen on basis of shovel size such that it can be loaded 4 to 5 bucket loads.

→ Hence with similar 35 or 50t capacity dumper are used, while the bigger shovels 85t, 120t or 170t dumpers are used.

→ 85t capacity dumper are diesel driven. 120t or 170t dumpers are diesel-electric.

→ It is a tyre mounted.

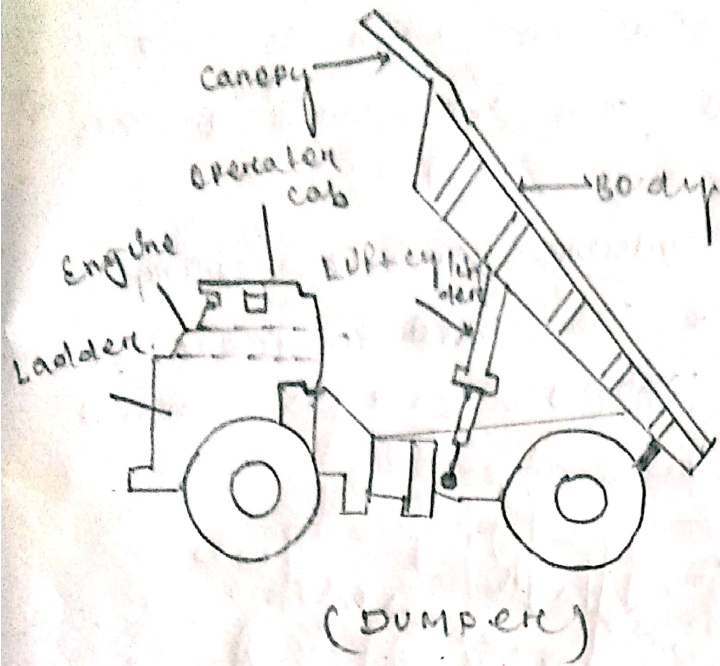
main part:

→ Chassis

→ Body and operator

→ Engine

→ Hydraulic system and air system.



Safety Features:-

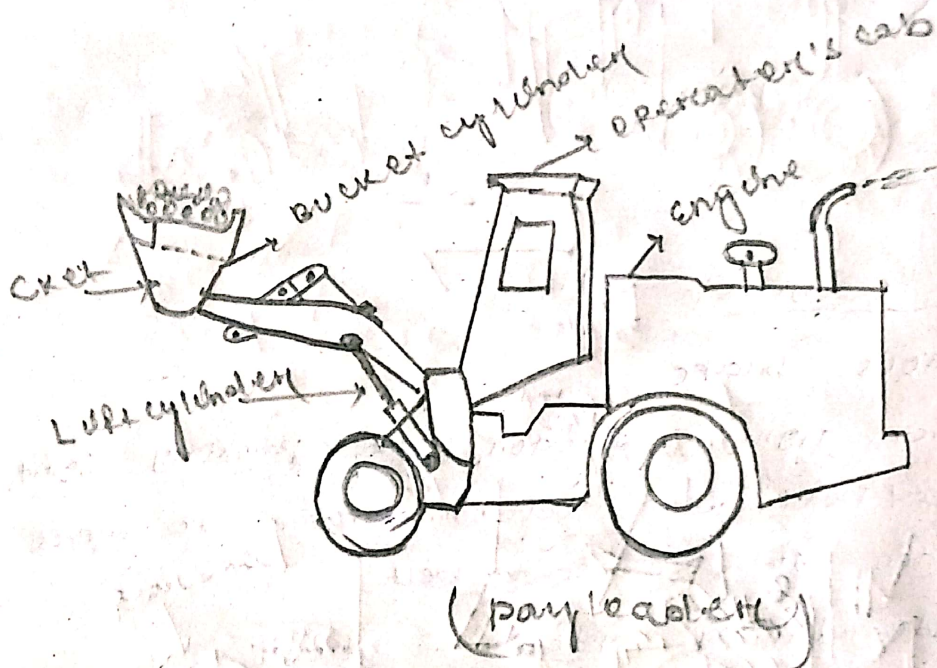
- various brake
- Horn, light, indicator, light, parking light
- seat belt with belt reminder to alert operator to use seat belt.
- Auto dipping system
- speed limiting device
- lifted ~~locking~~ body locking arrangement
- Rear view mirror
- AVA
- Propeller shaft guard
- cabin guard extension
- Tail gate protection
- Proximity warning device
- load indicator or recorder
- emergency steering.

Pay loader:-

→ Pay loader or wheel loader is type mounted loading machine which is used to load blasted coal into small trippers or dumper.

→ It is not suitable for OB loading.

→ The machine is called a front end loader because loading bucket is mounted at the front.



safety:-

→ same as the dumper safety.

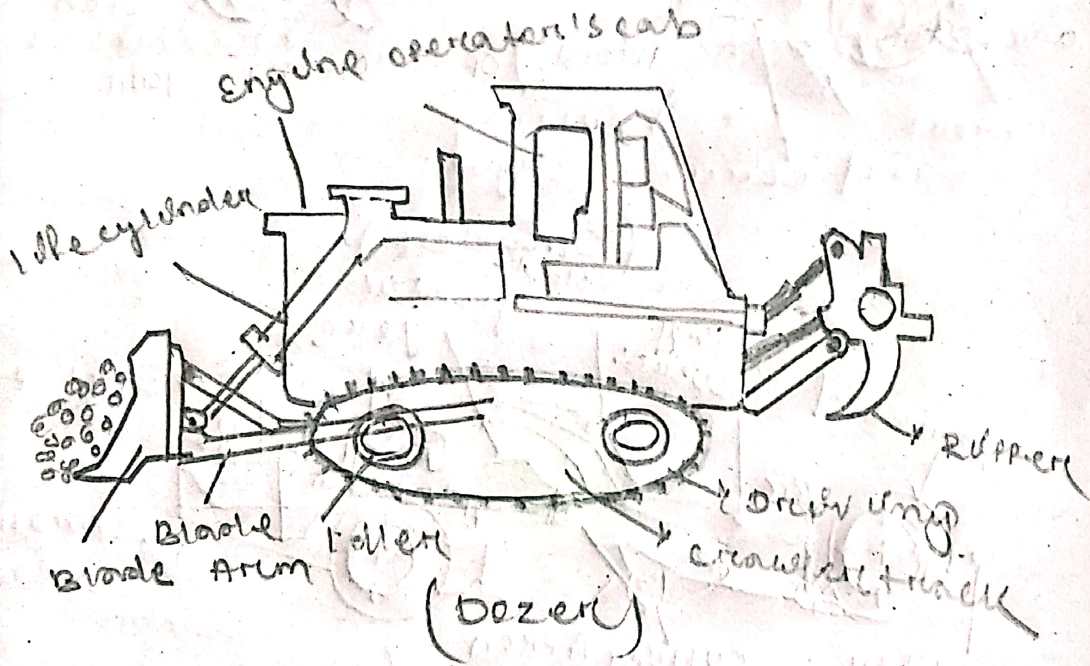
DOZER

→ It is diesel operated crawler chain mounted machine with a pusher blade at front for pushing loose material or for cutting soft earth.

→ It is mainly used in open cast mines.

Operation:

- pushing and gathering scattered blasted material for loading by shovel or payloader.
- cleaning the bench of coal/OB fallen during dumper loading by shovel.
- pushing and levelling material in OB or coal dump.
- preparing face or placement of drill.
- levelling uneven ground and bush cleaning.
- Towing break down dumper to repair shed or workshop.
- pushing scraper for loading.
- Dozer can work on gradient as 1 in 3.



Main parts

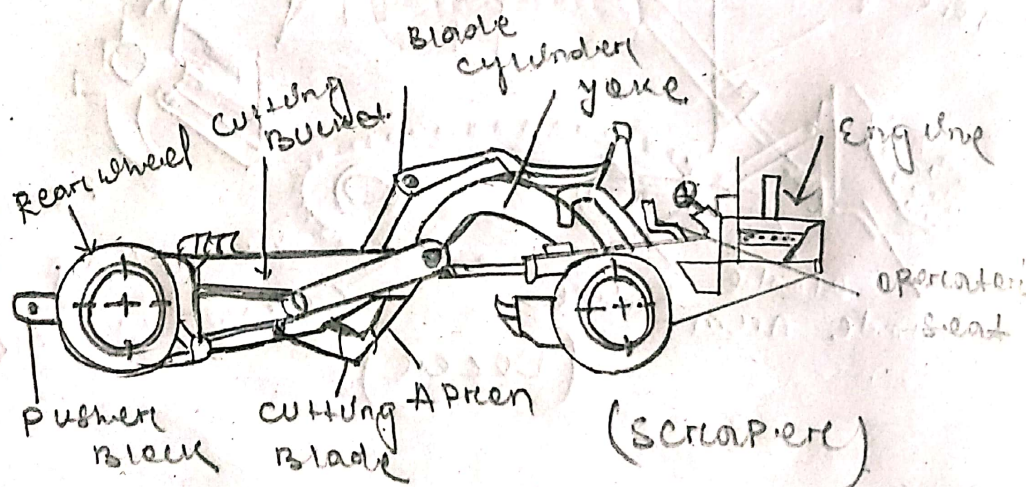
- Pusher blade
- Arms
- crawler chassis
- engine transmission
- Operator cab

Scraper

→ It is wheel mounted diesel powered open cast equipment.

If the machine has cutting bucket at its center front end of which can be raised or lowered with help of hydraulic pusher by movement of levers by operator cap.

→ A thin layer of 100-200mm is cut & by the time scraper moves 30-40m the bucket gets filled and front of end of the bucket is lifted and it's open and comes in front of closing door.

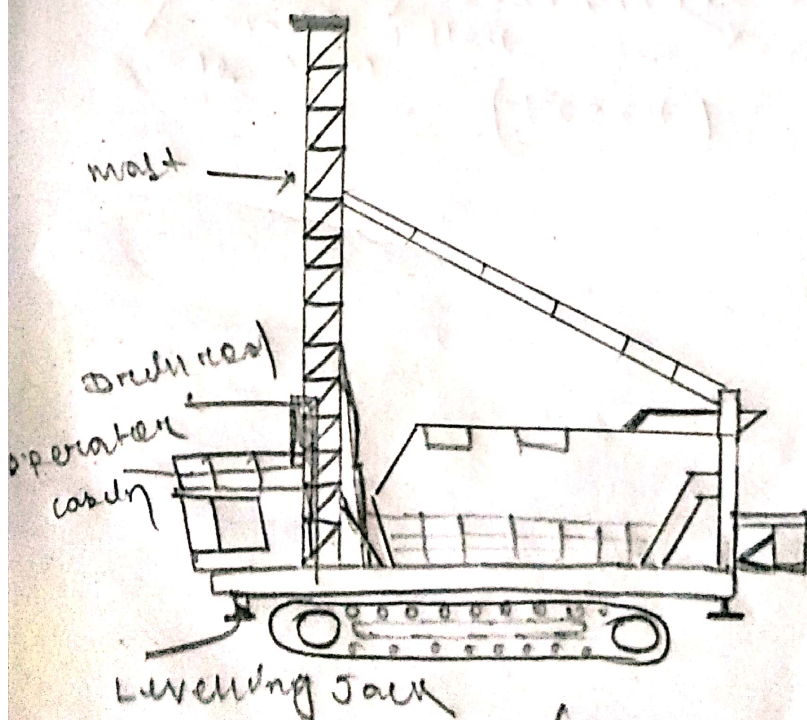


Blasthole drill

→ Rocker bit drill whose drill cutting are pushed out by compressed air it is known as blasthole drill.

→ In our country 150mm, 200mm, 300mm dia drillbit are available.

- It is mainly operated in electrically.
- It is mainly are crawler mounted.
- feed mechanism of drill is by hydraulic pumps.
- Road length is generally 10-12m.
- The machine can drill hole upto 3-5 mds in 30-50m.
- Blasthole drills are equiped with 3 hydraulic jack for leveling the machine.
- Dust from the blasthole is blown out by compressed air or extracted by dust exactor.
- some drills are equiped with angle drilling
- Before properting the drill from one place to another place the mast is lowered to prevent disbalancing and over turning machine.



(Blasthole drill)

Grader

- Grader is a machine for grading, cleaning and leveling the haviroad.
- It doesn't lift the material but just pushes the loose material to level the ground.
- It is normally wheel mounted and disc operated.

