www.MINEPORTAL.in

(All Mining Solutions)

DOWNLOAD MINEPORTAL APP FROM GOOGLE PLAY STORE

- **ONLINE TEST SERIES FOR**
  - **DGMS COAL/METAL FIRST & SECOND CLASS**
  - **GATE MINING**
  - **COAL INDIA EXAMS**
  - **OTHER PSUs MINING EXAMS**
- **FREE STUDY MATERIAL-MINEPORTAL NOTES & USER NOTES**
- **MINING VIDEO LECTURES**
- **DISCUSSION FORUM**
- **WHATSAPP CHAT SUPPORT FOR MINING EXAMS & QUERY RELATED TO MINING**

CALL/WHATSAPP- 8804777500

VISITING SITE- **www.MINEPORTAL.in** **Facebook-** **www.fb.com/mineportal.in**

EMAIL- INFO@MINEPORTAL.IN

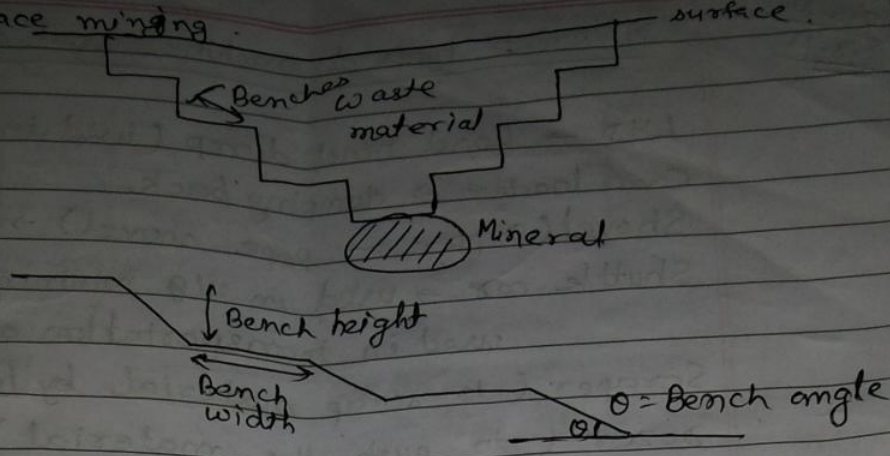
MINING OPERATION

www.MINEPORTAL.in

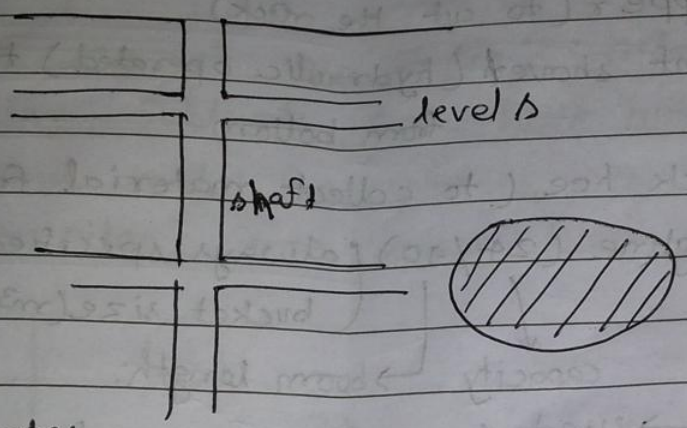
Mine development

O.S.N.
25.7.13

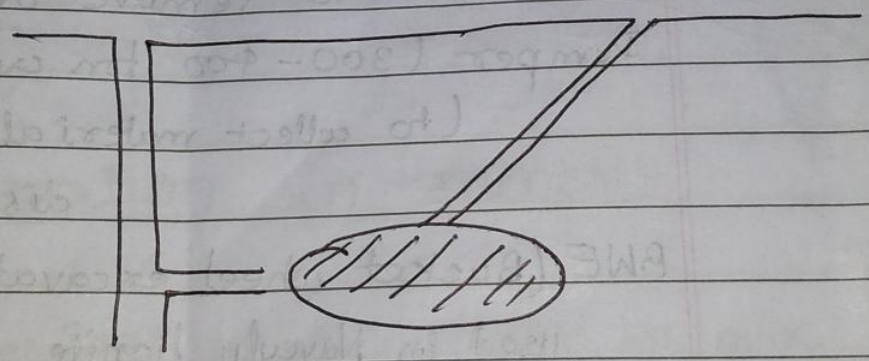
Surface mining



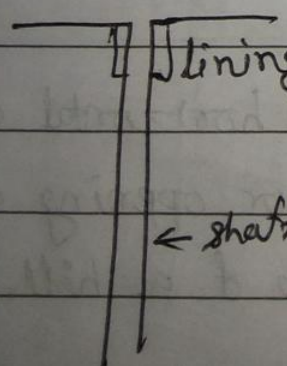
Underground Mining



Mine entry



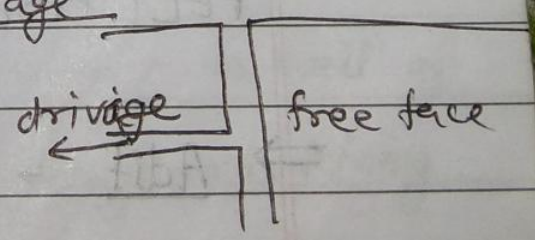
Shaft sinking

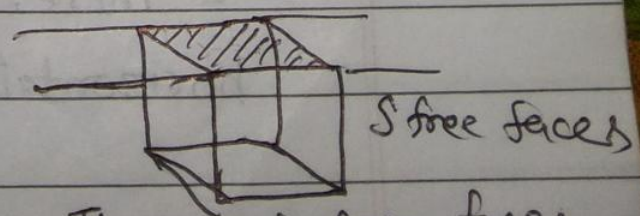


6 x 6 m
or Dia 6 m

prospecting
exploration
Development
~~Explora~~
production

Drivage





The more is free faces the more proper is blasting

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

O.S.N.
1.8.'13

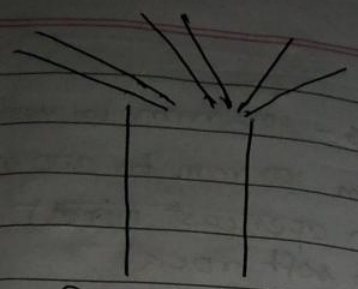
Different types of machine used in mines

LHD → Load haul dump (used in underground mines)
Cavo loader → dumping back
Shovel (Dipper or Rope shovel) → used in open cast mines
Shuttle car → used in u/g minining (6-7 m)
used in transportation of material.
Scraper (to scrap material by layer by layer)
Dozer (to push the material)
Grader
Ripper (to cut the rock)
Front shovel (hydraulic operated) to collect material from bottom.
Back hoe (to collect material from top)
Dragline (24/90) (always specified in terms of bucket size (m^3) and boom length)
- 24 → capacity
- 90 → boom length.
- → used to remove overburden.

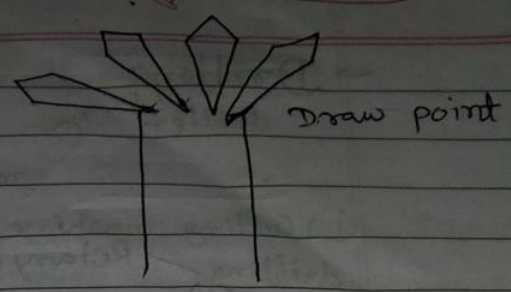
Dumper (300-400 ton capacity)
(to collect material from bottom and discharge at top)
BWE (Bucket wheel excavator)
used in Naveyly lignite corporation limited
FEL (Front end loader)

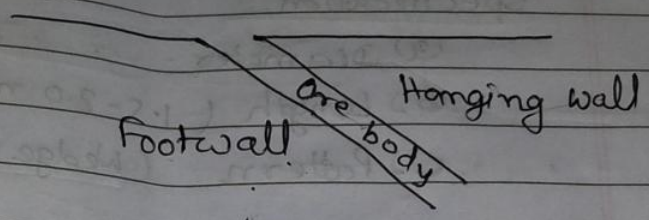
⇒ **Adit** → Horizontal or nearly horizontal entrance to a mine. A passageway or opening driven horizontally into the side of a hill.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

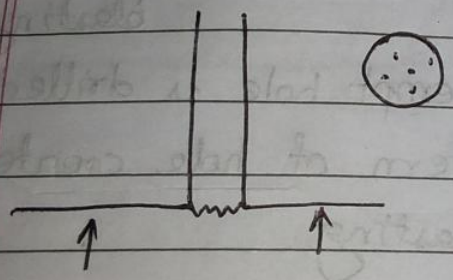


Finge raise





Chute, Cross cut, Dip, strike, Drift, level, manway, Sublevels, Bit, Blast hole, cage, Core, Diamond drill, Face, Gangue, Host rock, Stock pile, Stope, sump, Blast zone



Diamond coring bit

O.S.N.
2.8.13

Unit operation in mines

Unit operation → Step by step process in mine.

↓

Drilling
Blasting
Loading
Transportation.

} in open cast as well as in underground mining.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

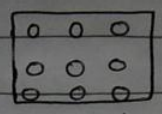
→ Drilling

driller dia - 36 – 100 mm in underground drilling

more than 100 mm to 300 mm (in opencast mine)

(i) Cutting machine drilling
- Rotary (used in soft rock)
- Percusive (used in hard rock)

Specification.

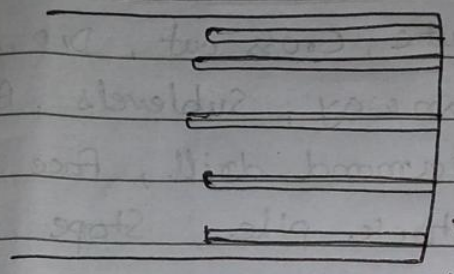


(a) Diameter

(b) Length (1.5 – 2.0 m) u/g development

(c) Pattern (Wedge & Burn)

→ ~~(ii) Solid blasting~~

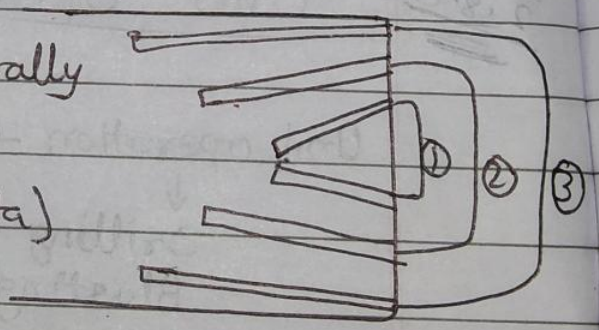


There is only one free face so there may be improper blasting so for creating free face, empt hole is drilled.

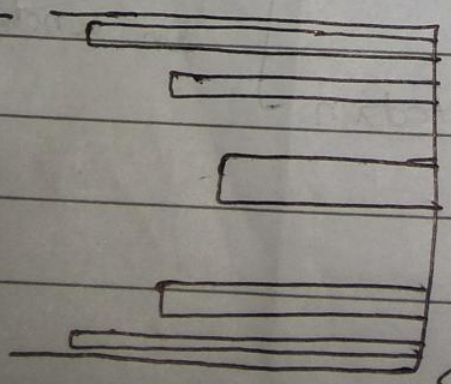
⇒ (ii) Solid blasting → Pattern of hole creates free face for another blasting.

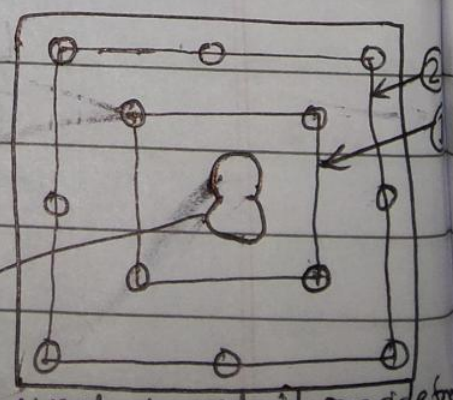
Wedge cut

wedge cut is used generally for coal mine and only for soft rock (soft strata)



Burn cut





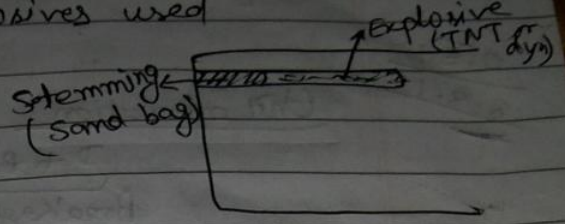
This hole is not charged, it provides free face for another blast

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Drill depth 1.8 m & Pull or advance 1.5 – 1.6 m

→ Blasting :

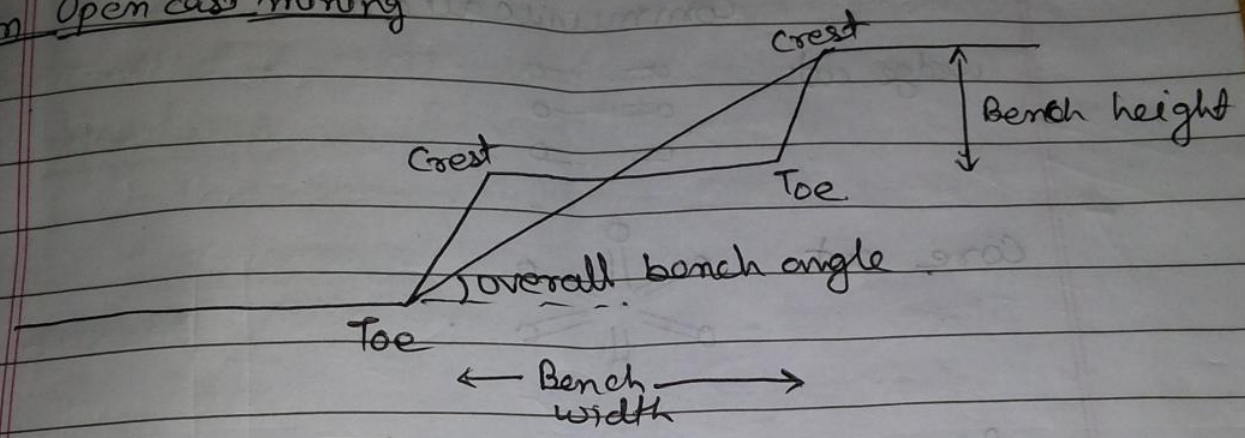
changing
Blasting pattern (sequence of blasting)
Explosives used

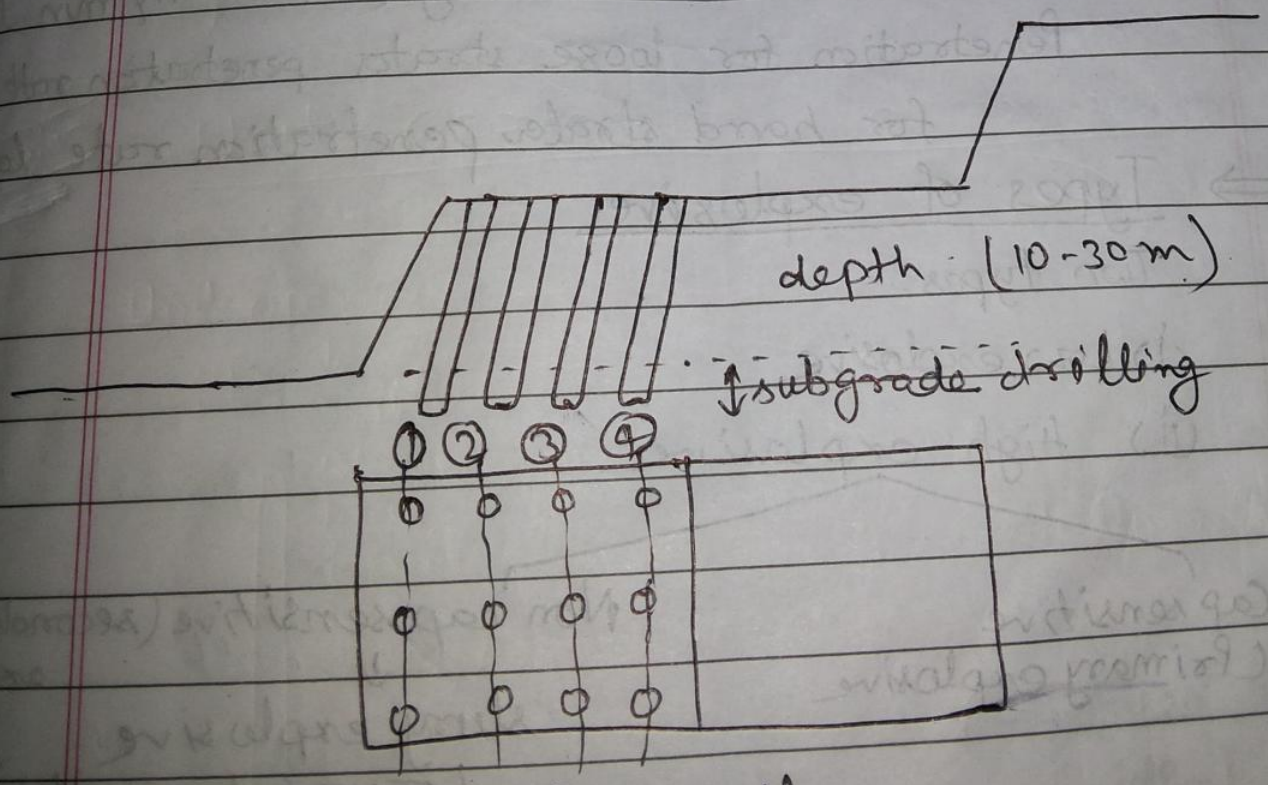


If mine is of coal, specific explosive is ~~used lemma~~ used.

P_1, P_2, P_3, P_4, P_5

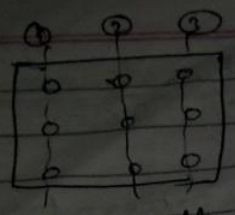
In Open cast mining



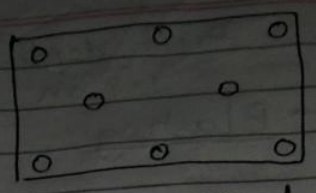


square Drilling pattern.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in



square pattern



Straggered Pattern

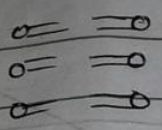
O.S.N.
8.8.13

Unit operation

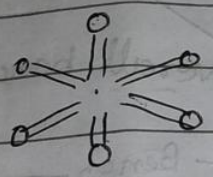
$\underbrace{D + B}_{\text{Breakage}} + \underbrace{L + H/T}$

Auxiliary operation → Ventilation, Roof support power supply, maintenance, pumping communication

wedge cut



Core cut



Penetration → rate of drilling (m/s or m/min)

Penetration for loose strata penetration rate high

for hard strata penetration rate low

⇒ Types of explosive

Two types.

(i) Low explosive

(ii) High explosive

Cap sensitive (Primary explosive

Non cap sensitive (secondary explosive)

↓

slurry explosive

(TNT (dyramite))

100 kg slurry requires 20-30 kg of TNT.

Loading

Undercut

Overshot

Sc

→ Overs

ma

ex

→ Auto

Ha

→

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Loading / Mucking

Underground
Overshot, Auto loader, Scraper.

Surface mining (Open cast)

→ Overshot → It is used generally to colled material from its front and discharge back of itself. (Put behind it)

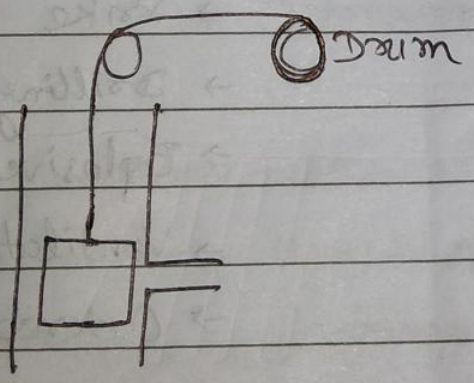
→ Auto loader
- LHD (Load, haul, dump), Shuttle car
- SDL (Side discharge loader)
- LPDT (Low prifile dumper truck)

Hauling or Transportation

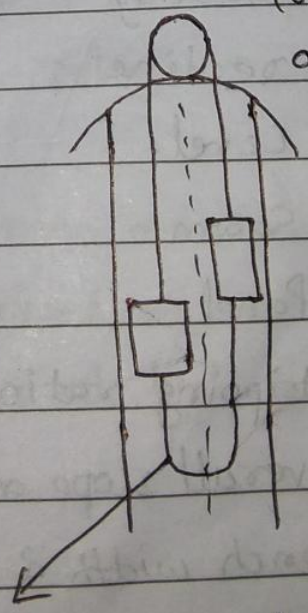
Underground mining

U/g hoisting
- Drum
- Koepe hoisting

→ Drum type hoisting



Koepe type



Tower system at least two cages are required, Here it works only due to friction between drum and rope.

Tail rope (used to reduce initial

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Haulage
- Track haulage
  - rail/Locomotive (operated by diesel, batt or electric)
  - Direct, Endless & Main and tain haulage
- Trackless haulage (LHD, Dumper, SDL, LPS shuttle car)
  - Tyre
  - crawler

→ Pipes
→ airway (aerial rope way)
→ Explosive and blasting
→ Mine entry
→ Secondary development
→ Primary development (Shaft sinking and entry or first approach to the mine)

O.S.N. 22.8.13

Mining terms

→ Underground mine
→ Shaft
→ Haulage
→ Incline
→ Gallery
→ Decline
→ Level.
→ Seam
→ Panel.
→ Stripping ratio
→ Overall slope angle
→ Bench width & angle
→ Angle of repose
→ Hanging wall
→ Downcast shaft

→ canop V
→ Head ~~frame~~ frame
→ Goaf
→ Dip
→ Strike
→ Drilling
→ Explosive
→ Ventilation
→ Outcrop
→ Percentage extraction
→ Pillar
→ Roof bolt
→ Upcast shaft
→ footwall
→ Raise/winze

→ Natural ver
→ Cage/skip
→ Surface
→ Overburd
→ Bench
→ Manway
→ Manhol
→ Sump
→ Unergro

→ Stripping

O.S.N. 22.8.13

→ What
→ Wha
→ low
→ Nitr
→ Amm
→ TNT

→ G

→ T

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

→ Natural ventilation
→ Cage / skip
→ Surface mining
→ Overburden
→ Bench
→ Manway
→ Manhole
→ Sump
→ Unerground operation
→ Cross cut
→ Chute
→ Finger raise
→ Drawpoint
→ Grizzle
→ Orepass
→ Bord and pillar
→ Unit operation
→ Open cast equipment

→ Stripping ratio = $\frac{\text{waste material (in } m^3)}{\text{Ore excavated (in ton)}}$

Q.S.N.
22.8.13

→ What is explosive ?
→ What are important properties of ~~exp~~ explosive ?
→ low & high explosive ?
→ Nitroglycerine
→ Ammonium nitrate
→ TNT

- Detonator Plain, Ordinary electric, Delay detonators
- safety fuse
- nonel

→ It is solid or liquid substance or a mixture of substances which change themselves instantaneously into a large volume of gases of high temp and pressure

→ Types of explosive

low explosive

Charcol (Gun powder)

High explosive

speed of propagation of wave → high

burning rate < propagation of wave

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

low
Gunpowder → mixture of charcol + sulphur + KNO_3
- It can be fired with safety fumes.

→ High explosive
→ Nitroglycerine.
It is in form of liquid. Very sensitive to temperature and shock.
→ Ammonium nitrate
Very powerful explosive. It can't blast with detonator
To blast it requires booster (another type of high explosive)
→ Cap-sensitive can easily blast with help of detonator
→ Non-cap-sensitive can't " " " " " " "
it required booster.
In o/c we use non-cap sensitive
→ Booster (TNT + Dynamite). water sensitive, speed = 7000 m/s
→ ANFO (ammonium nitrate & fuel oil)
mixture should be proper. by weight 6% fuel oil and 94% ammonium nitrate)
7 lit fuel oil + 100 kg AN.
It can't be used in watery hole.
→ Properties of explosive
→ Strength
→ Velocity of detonation
→ Density
→ Water resistance
→ Fume characteristics
→ Sensitive
→ legal permission.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

12

D.S.N
23.8.13

Explosives

- Primary / Initiator explosive
- Secondary explosive
- High explosive
- Deflagrating or low explosive

→ Commercial (Mining & civilian work)

Booster.

ANFO

PETN (Penta Erythryl tetra nitrate)

In permitted explosive collard NaCl, KCl, NaF

P_1

P_2

P_3 → Equivalent sheathed.

P_4

P_5 → Off the solid explosive (for solid blasting)

dia = 100mm

slurry = 1.3, emulsion – 1.5 density.

First booster → slurry explosive.

Select exp → ANFO, Slurry, Emulsion.
100%

Calculate volume of hole.

Assume percentage of hole charged. (90-60%)
(main exp + sec. expl.)

100
↓
~~20-90% booster~~
↓
80-60% slurry

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Emulsion, slurry → Non cap-sensitive
Nitroglicerine, ANFO → cap sensitive

$V = 3.14 \times (0.1)^2 \times 10 = \frac{0.314}{4} = 0.0785\ m^3$

Volume to be filled $= \frac{0.0785}{2} = 0.03925\ m^3$

Explosive Initiating Devices / systems

- Detonator system
  - Instantaneous detonator
    - Plain
    - Delay detonator
  - Delay detonator
    - Electric
      - long delay (Half second)
      - short delay (Millisecond)
    - Non-electric
    - electronic
  - Special types detonator
    - delay
- Fuse system
  - safety fuse
  - Detonating cord

Detonators

→ Detonation is a process of giving sufficient violent shock to the explosives for explode

→ High explosive needs detonator.

→ detonator is small copper or Al tube containing essentially a small auxiliary charge of special explosive

Types

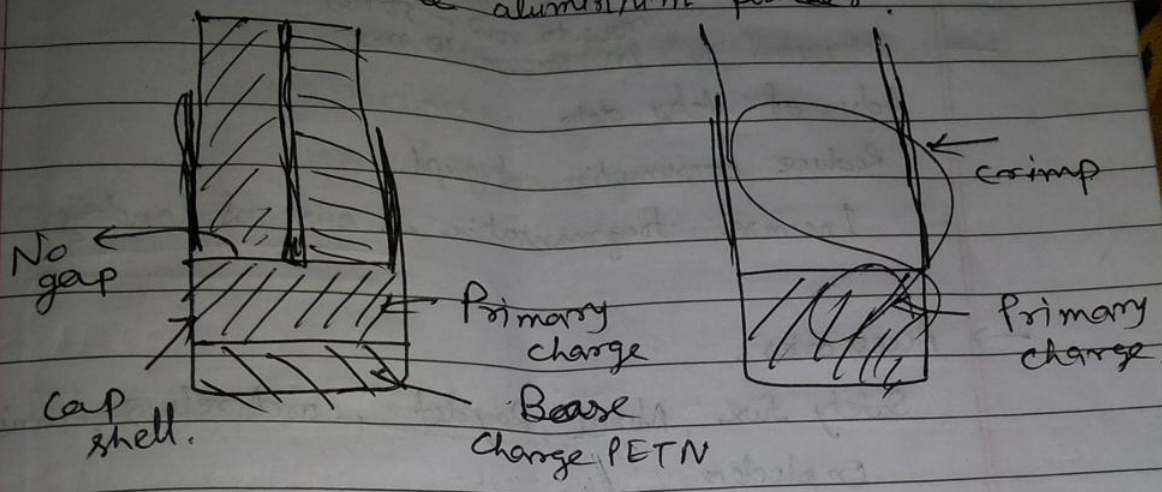
Plain detonator, ~~Ordina~~ → fired by safety fuse spark from fuse causing detonator explode

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

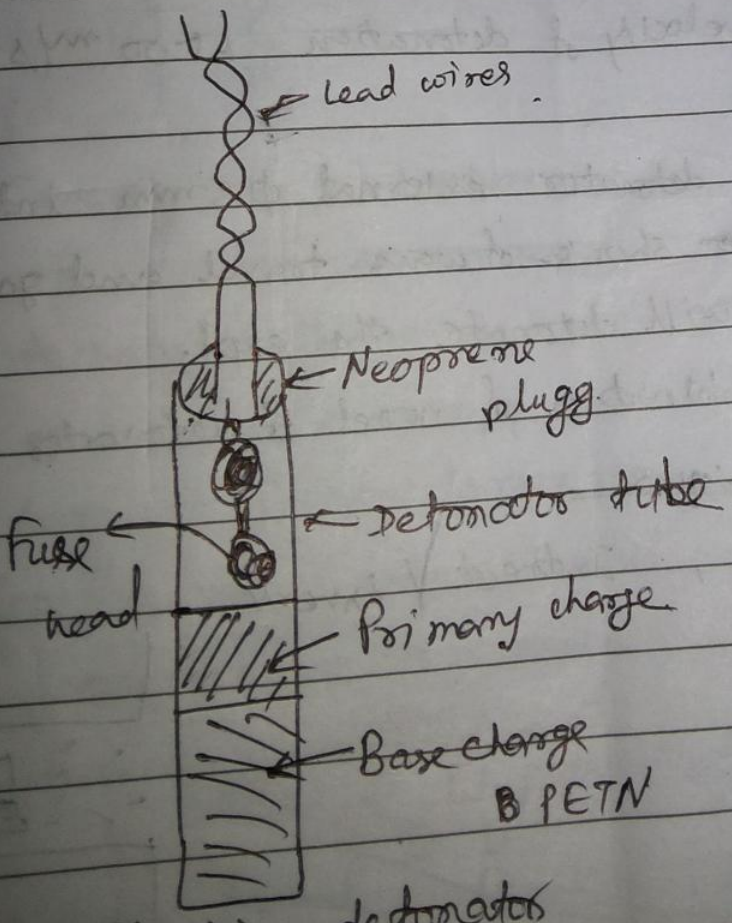
Ordinary electric detonator → fired by passage of current through detonators
Delay detonator → Having a delay element.

→ Plain detonator

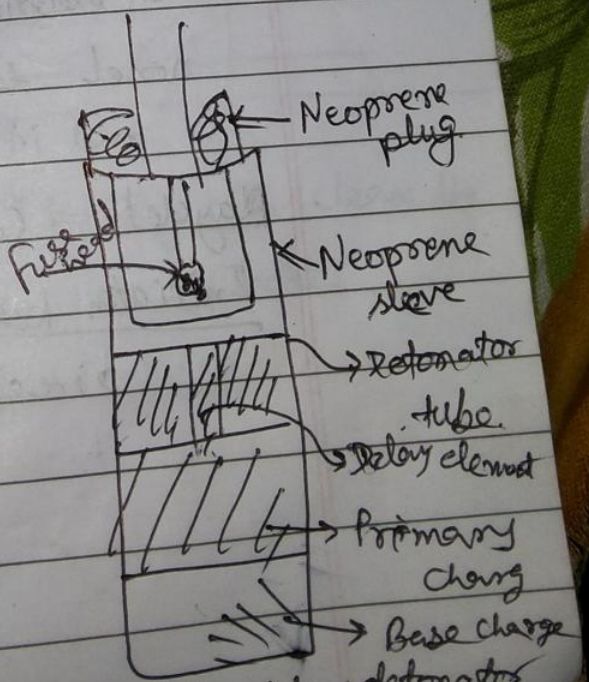
Al tube ϕ 6mm, length 37 to 50 mm.
~~ASA~~. 1/3 with ASI & PETN.
A.S.A. = Mixture of lead azide, lead styphnate and little aluminium powder.



Delay detonator → As voltage is applied

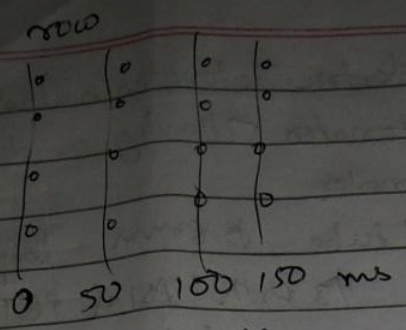


Electric detonator



Electric delay detonator

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in



row to row blasting → gives delay between row to row
row to row - 50ms
in row - 10 ms

Adv. of delay deto
Reduce consumption of expl.
Increase fragmentation & ease of loading

→ Accessories.
Safety fuse, Nonel, Raydet, cord relays, Circuit tester, Exploder.

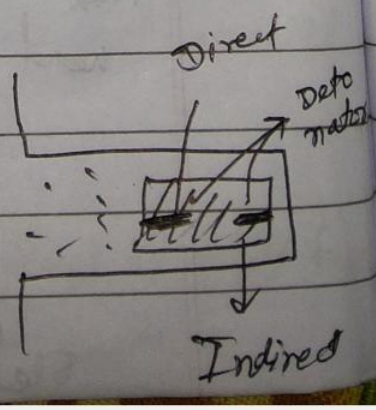
Safety fuse looks like cord.
Burning speed 100 - 120 m/s

Detonating fuse
velocity of detonation 6500 m/s.

Nonel
non electric detonator external ϕ 3 mm internal 1.5 mm
nonel ~~deto~~ shock wave travel and go to detonator and it will detonate the expl.

Raydet → Combination of nonel & detonator.

Initiation techniques
Direct, Indirect / inverse.



Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Detonating relays

Classification of expl. on the basis of e

class 1 → Gunpowder

2 → Nitrate mixture, Pentadyne

3 → Nitro compound, Gelatine, permitted, TNT

4 → Chlorate mixture.

5 → Fulminate.

6 → Ammunition safety fuse, detonators etc.

7 → fireworks.

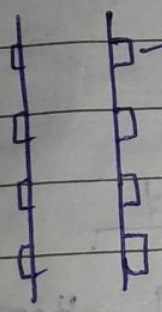
8 → Liquid oxygen explosives

Circuit tester

Exploder

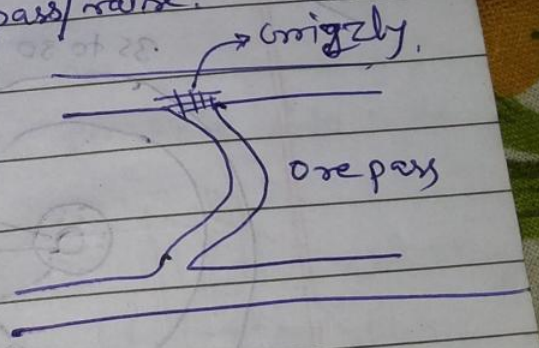
Destruction of explosive

O.S.N.
30.8.13



→ Manhole (For safety purpose of man)

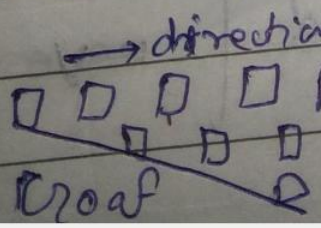
Grizzly → a cross linked structure of iron rod above the hole of ore pass/raise.



Canopy → is a structure just ~~to~~ of iron or any metal to support the person. we can stall the canopy on bars. It covers larger area.

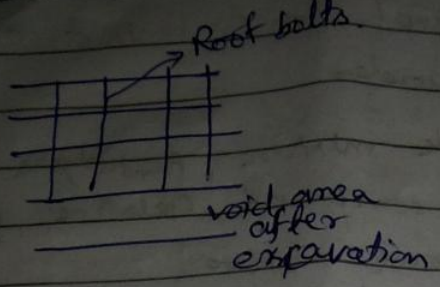
Flushing → To clean the hole.

Goaf → used in only u/g mines. unsupported large mine area



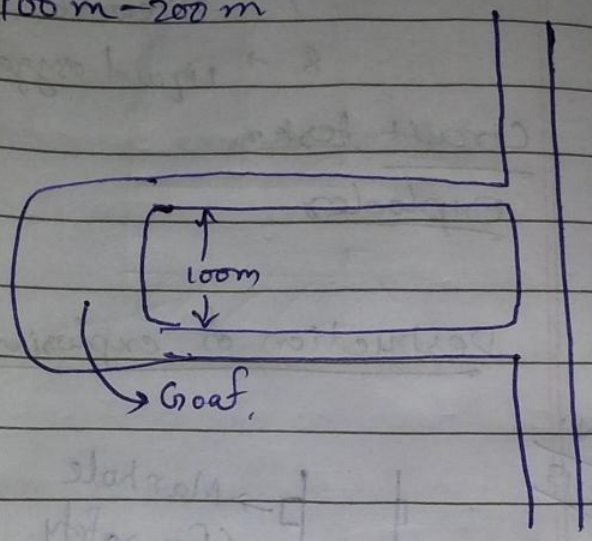
Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Roof bolt is used to support the immediate roof.



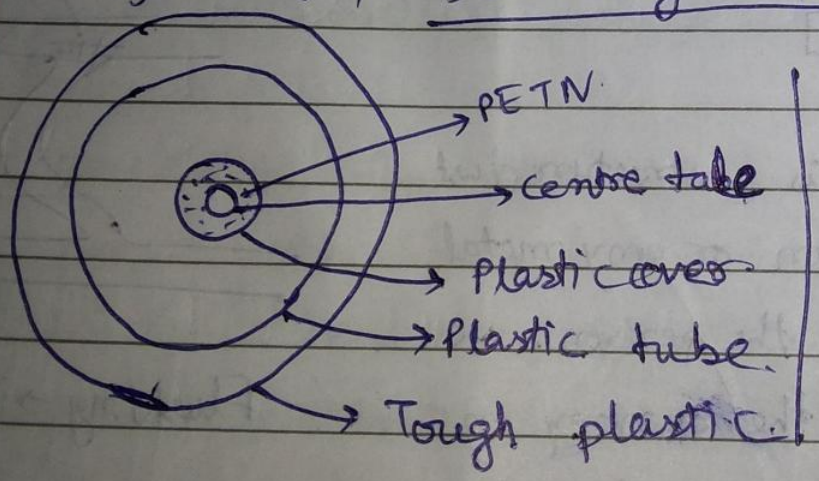
→ Cross cut → used in metal mines

→ longwall → used in u/g mine when depth is very long working face is 100 m – 200 m



13

35 to 80 gm/m Detonating cord



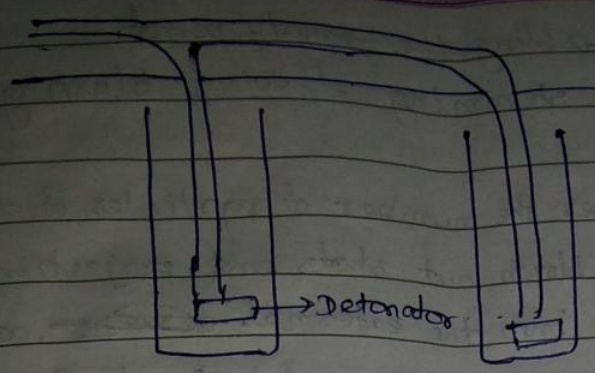
~~Hercudet system.~~

ercudet system

only 5 to 10% of explosive is burnt not blasted.

in nonel in which shock wave passes.

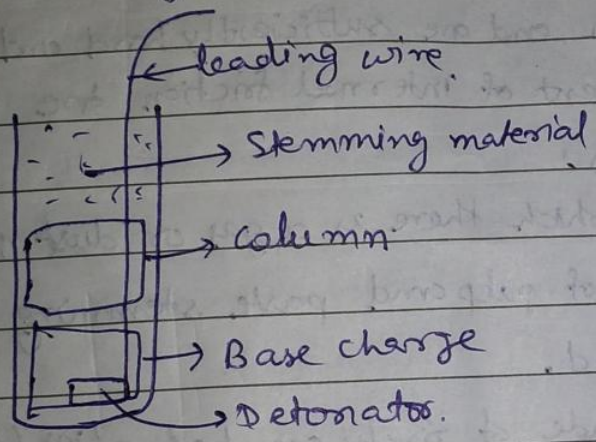
Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in



inside the hole only gas is filled.

inner tube is filled with oxygen and fuel oil, and ignition is made.
less chances of leakage.

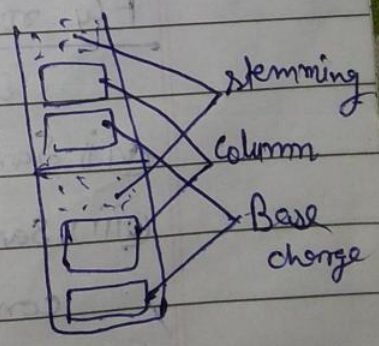
Stemming



If stemming is more compact vibration would destroy surrounding land and structures.

used generally in o/c mining.

when hole is long we divide the hole into a no of no of steps.



Purpose of stemming is to confine the gaseous products formed by combustion/detonation of explosive, until the pressure generated is sufficient to burst the containing strata.

→ Stemming is the one of the important material and parameter for proper blasting

→ As hole dia increases; spacing between holes may be increased.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

~~Process of filling the empty pores~~.
More rigid stemming effective blasting.

advantages.

i) It decreases the number of particles of fine dust in
(ii) It prevents blown out shots and projection of flame and hot gases into the external ~~resistance~~ atmosphere
(iii) Stemming increases the resistance to the escape of gaseous detonation product.

(iv) Friable materials that are inert to the action of an explosion and are sufficiently hard and have a high coefficient of internal friction are usually used for stemming.
(v) In shafts in which there is a gas or dust hazard, various types of pulp and paste stemming materials are also used.
(vi) Stemming made of finely crushed chips (to 20 mm) and siftings from crushing and sorting plants is used in wells.

Fly rock → Projection of rocks or explosive after blasting in air.

(vii) Sand forms the most efficient stemming material
(viii) Sand size between 0.245 mm to 1.587 mm conjuction with clay.
(ix) Sand and clay reduce the cost of explosive to the extent of 33%.
(x) The length of the stemming may be only 8-10 times the diameter of blast hole.
→ In shafts with gas and dust hazards the length

0.5.N.
6.9.13

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

of the stemming is governed by the safety regulation.

→ Planning issues is controlled by IBM.

Water stemming

- Water filled in the bag is also used for stemming purpose
- It reduce the fire damp ignition.

→ Process of rock blasting

(i) face survey (ii) drilling the shotholes.

(iii) checking the holes (iv) Charging with explosive and stemming top (v) Detonating the explosive

(vi) Shotpile ready for loading.

→ Advanced method of stemming.

(i) Void blasting (ii) Air blasting (iii) Full loading.

O.S.N. 6.9.13

Magazine

General guidelines for magazine.

- No iron piece should be on roof
- Proper lightening
- Fire extinguisher should be there.
- Detonator should be stored separately from explosive.
- Detonator kept in wooden boxes.

Procedure of blasting.

check damp,

blasting pattern, charging, proper delaying,

check the circuit.

* In u/g mine cartridge explosive is used.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Common mistakes

i) Not taking proper cover.
in bord & pillar method, leave two/three pillars

(ii)

(iii)

(iv) Careless in handling detonator

(v) Return the blast area after at least 20-30 minutes after blasting so that fume is less.

LOX Liquid oxygen

another type of explosive

at −183°C it converts into liquid at which O_2 present in high amount. Don't require detonator or booster. It deprelops high pressure.

Testing of explosives

→ Cap sensitive test → to check, whether explosive is cap sensitive or not. Amount of PETN governs detonator number. A small amount of explosive is blasted with no 6 or no 8 detonator.

	PETN	L	dia
No. 6	30	32 mm	6.5 mm
8	60	37 m	7.7 mm.

Booster sensitive

If expl. is blasted with the help of booster, it is booster sensitive.

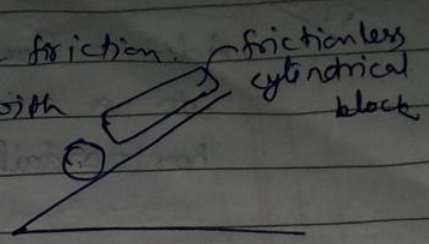
Impact sensitive test → A bed if blasted with dropping impact sensitive.

1 kg, 5 kg or 10 kg if blasted after dropping from 1 m height.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Friction impact sensitive test

An expl. should not blast during friction. cyl. block move downward with expl. If expl. blast, it is sensitive with friction.

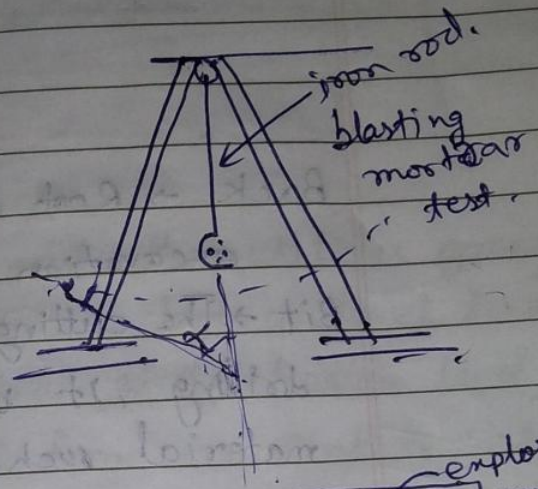


amount of expl. is taken 5 gm.

Blasting Strength test

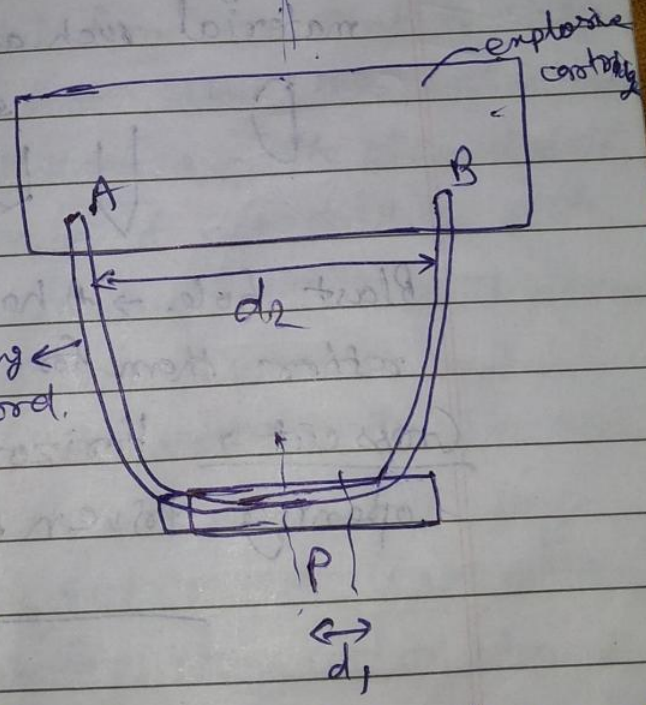
$$S = \frac{1-\cos\alpha}{1-\cos\beta}$$

α = angle of



VOD test

length of A & B from B is equal. If A and B is blasted at same time it will reach P at same time.



$$D = \frac{d_2}{2d_1}$$

D = Detonating velocity of ~~detonator~~ detonating cord.

1. VOD 2. IST, 3. FIS 4. Strength test

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

O.S.N.
19.9.'13

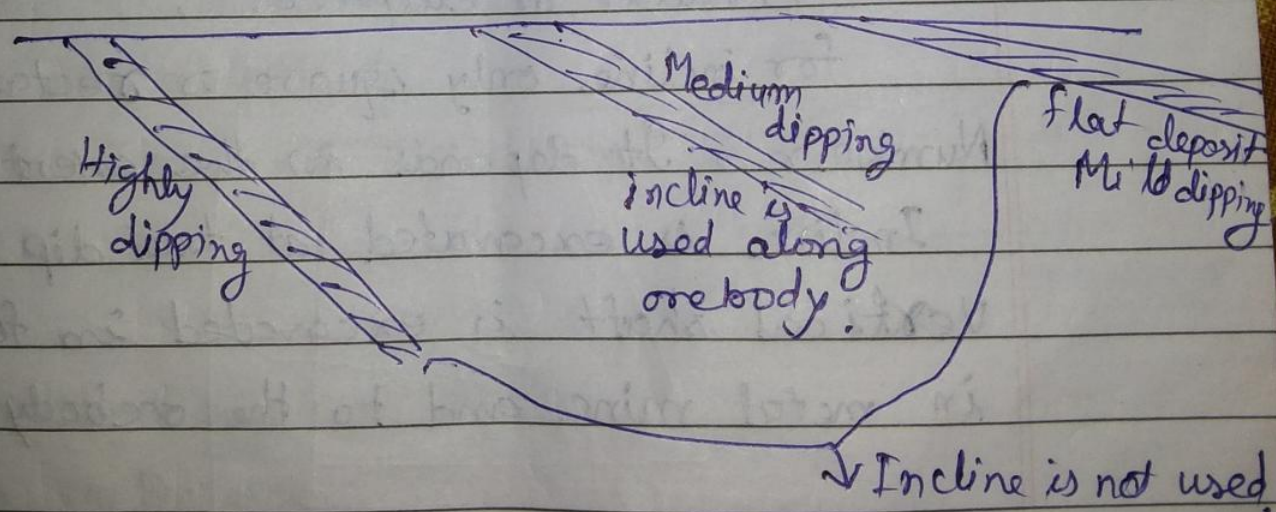
Mine Entry

For underground mine.	for open cast mine.
Shaft	Haul road
Incline	
Adit	

* Incline & Adit is used for shallow deposit.
* For hilly area or where ore deposit is above the surface, adit is used. In open cast mine, to excavate bottom minerals, size of adit 2m×2m or 4m×4m. It is used mainly in metal mines.

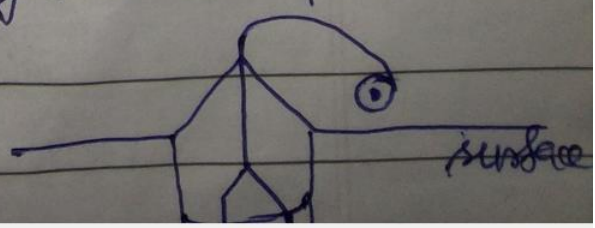
→ Incline → Used when dipping is 1 in 4 or more (should be steeply dipping). If it locomotive is used. It depends on the extent of orebody, size, width location, depth, dipping, thickness of ore deposit. If depth is less than 100m, we go for incline. If depth is more, we go for shaft.

Incline is used when orebody is at the outcrop



Excavation cost of shaft is high with compare to incline.

During sinking of shaft



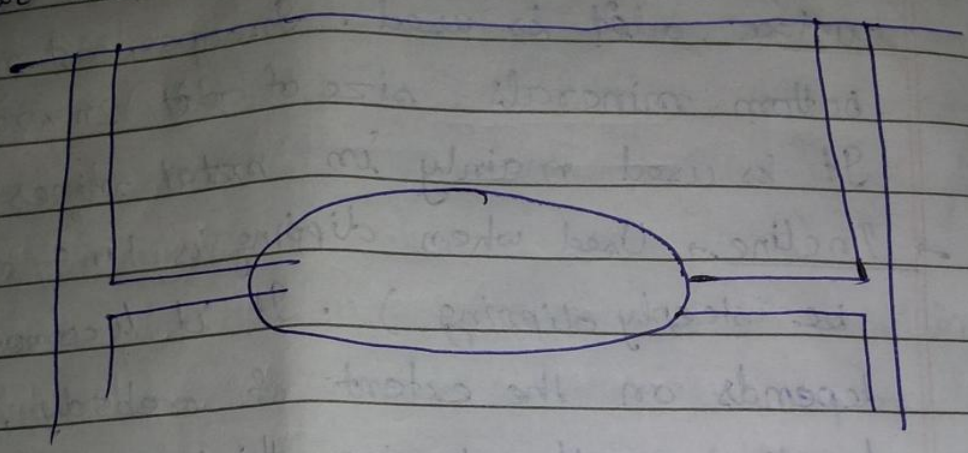
Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

(1)

Location, size/width/thickness, extent, dip, depth are different measures on which mine entries are selected

Extent of orebody

If extent is very low, we don't excavate shaft, we choose incline due to cheaper excavation cost. If extent is high, we excavate incline and two shaft



Size

Shaft → 4-6 m dia

incline → 3×3 m or 4×3 m

Shape → for shaft we use square, rectangular, circular or elliptical,

for incline only square or rectangular shape is used.

Number → It depends on the extent of orebody.

Incline is excavated at true dip

Vertical shaft is excavated in footwall side in metal mine and to the orebody in coal mines

D.S.N. 20.9.13

D.S.N. 3.10.13

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Q.S.N. 20.9.13

Distinction of Shaft and incline.

Points	Shaft	Incline
(i) Depth		(30-50 m)
(ii) Dip angle (0-90°)	Flat seam & steep dip (large extend)	Medium dip
(iii) Extent (Ore reserve)	large	Small area
(iv) Outcrop		incline.
~~(v) Type of deposit~~		
(v) Thickness	Maxm	less

S.N. 10.13

Shaft pillar → Solid rock around shaft which is left unexcavated to protect surface structures.

① $R = 3\sqrt{Dt}$ D = Depth, t = thickness of seam

② 100 m = 36.5 × 365

every depth d

36.5 increased 9m.

③ $R = \frac{18.5 D \sqrt{t}}{32.8}$

④ Based on angle of draw.

⑤ For incline ~~size~~

rise side $= S + D/7 + 2Y/3$

dip side $= S + D/7 - Y/3$

along strike $= S + D/7$

$Y = D \sin\theta . \cos\theta$, θ = angle of seam

S = Margin of safety (5% - 10%)

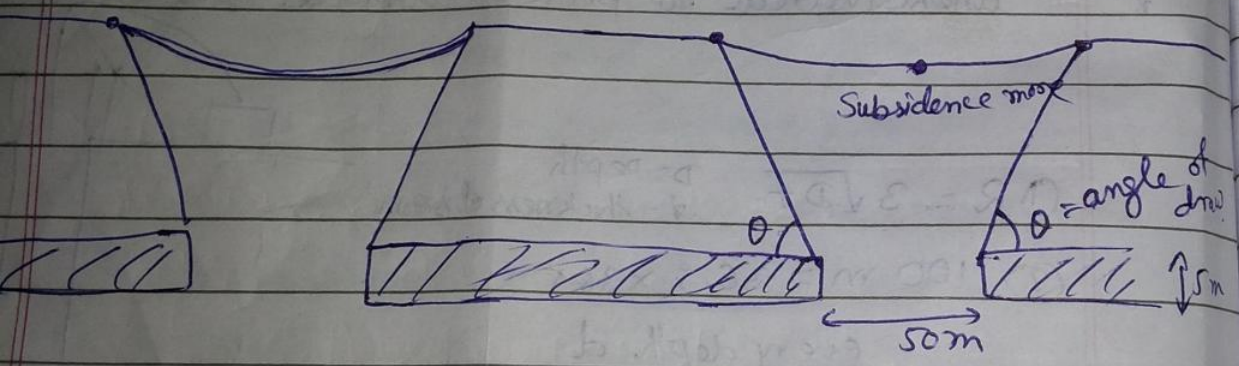
Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

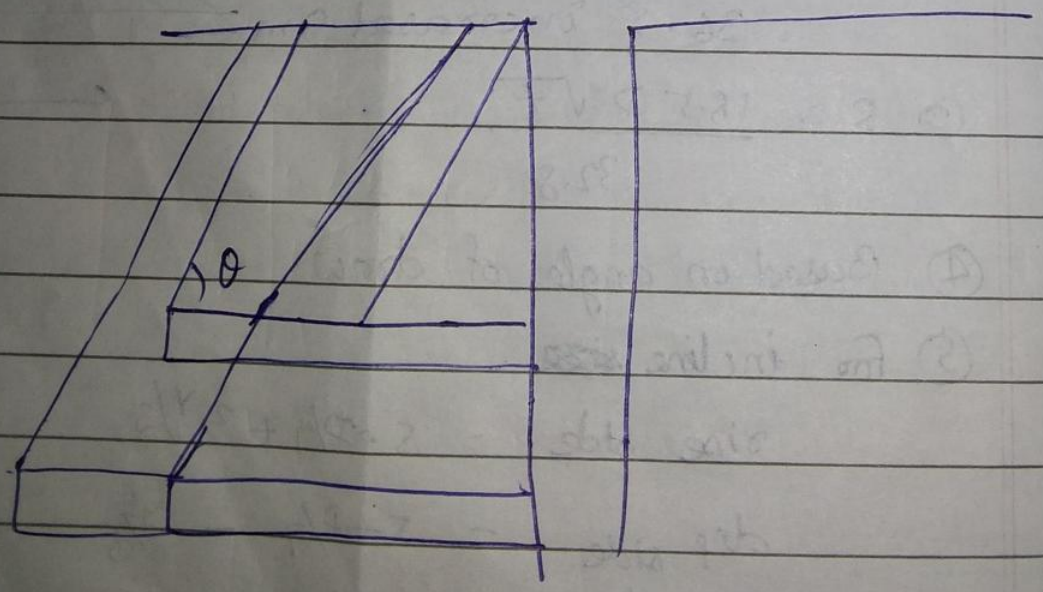
Shaft is of importance when we have to excavate mineral at depth

Based on angle of draw

Subsidence → lowering of surface due to mining activity

Subsidence decreases with increase in depth





D.S.N.
24.10.13

Cross-me

When see
we can
we excav
cross-m
we ex
from
When
to cr
co

Drive
→ Secon
D
in
→ In c
we

Im

Crat

ift → Stone

vel → Coal.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Cross-measure drift & lateral

When seam is of high inclination we can not excavate levels, so we excavate stone which is called cross-measure drift. Then we excavate ~~mineral~~ incline from cross-measure drift.

When we excavate mineral at perpendicular to cross-measure drift to access the mineral which is at seam of two and fro of seam.

D.S.N. 4.10.13

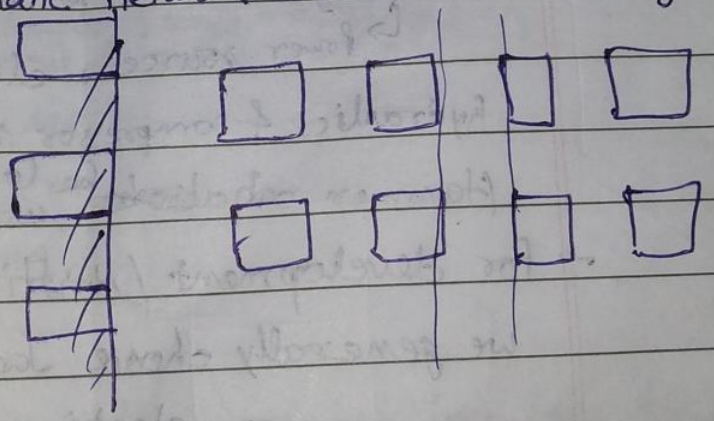
Drivage in stone / coal or Secondary development.

→ Secondary development → gallery, levels, may be incline.

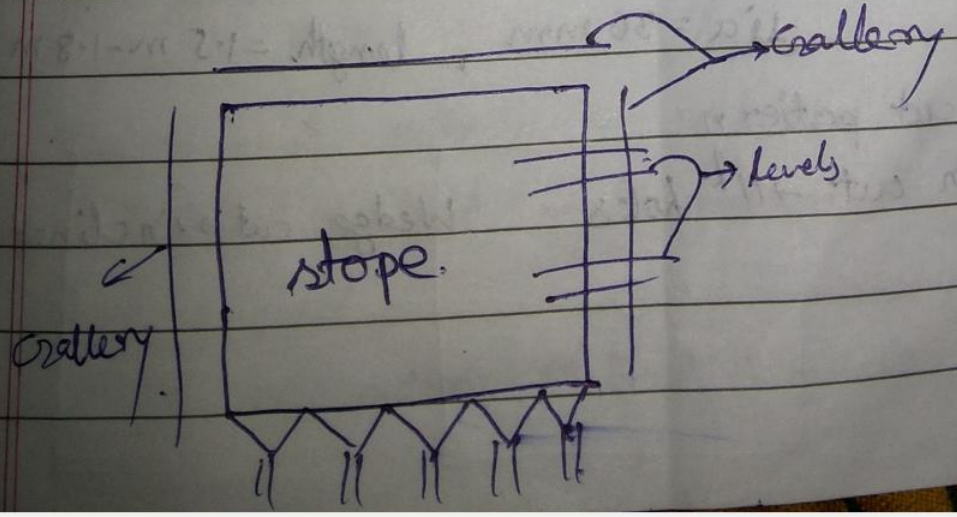
Drivage
↙ in coalmine → In metal mine

→ In coal mine

we create a systematic network to reach the boundary of coal



In metal mine.



Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Coal seams

thickness of coal seam
- < 1.5 m → thin deposit
- 1.5–4.5 m → moderate "
- > 4.5 m → thick "

based on depth
- $d < 100$ → shallow deposit
- $100 < d < 400$ → moderat depth
- $d > 400$ → deep mine.

Based on inclination

if
- $\theta < 5^\circ$ → flat deposit
- $5-18^\circ$ → incline
- $18-90^\circ$ → steep
- > 90 → very steep

Procedure for development of drivage.

unit operation → D + B + L + T

~~see~~ auxiliary operation → V + S + D/P + L
- V → ventilation
- S → support
- D/P → Drainage/pumping
- L → Lighting

Drilling

Percusive → rock is break in tension

rotary → rock is broken in shearing.

↳ Power source → electric / hydraulic / compressor

hydraulic & compressor is also used in hammering.

Hammer can be located at top / bottom.

→ for development / drifting

we generally choose Jach hammer / drifter (used in metal)

or electric coal drill (used in coal)

dia = 36 mm, length = 1.5 m – 1.8 m

Drilling cut pattern

Burn cut → ⊥ holes

Wedge cut → inclined holes

wedge cut

Burn cut

Boundr

Trean

peri ph

Grase

Cut h

Burd

dist

dist

Bu

S

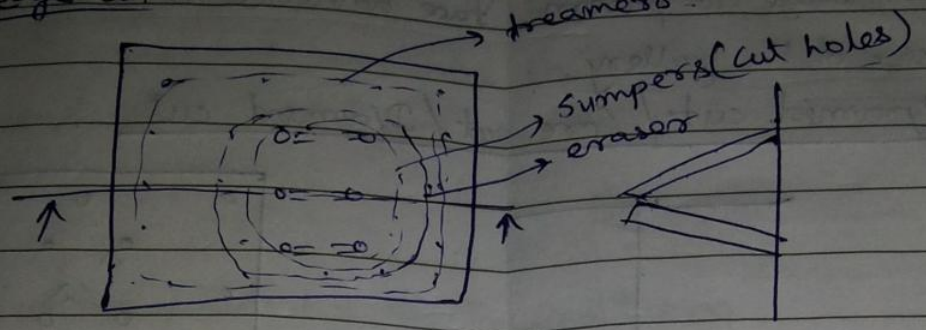
e

O.S.N.
25.10.13

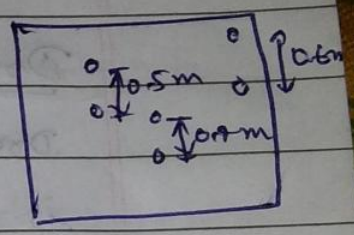
Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

wedge cut pattern is used in coal or softer strata.
Burn cut pattern is used in stone or hard strata.

wedge cut.



Boundary holes are lightly charged to just smooth the surface.
Treamers are drilled at a interval 0.6 m near to the periphery, and incli
Eraser → It is generally 0.5 – 0.6m interval.
Cut holes are at 0.4 m interval



Burden & spacing

distance between row is called burden.
distance between holes in a row is called spacing

Burden = (0.4 to 0.8) × l.
Spacing = (0.6 to 1.2) × B ← B → burden.
to calculate no of holes 1st method

2nd method → Pauder factor. (unit → ton/kg)
amount of coal

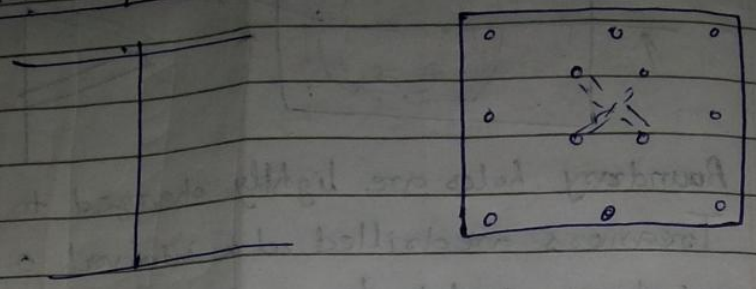
e.g. 3 × 4 m 1.5 m depth
V = 1.8 m
1.8 × 1.2 =

Wedge cut pattern

Sumping → First hole which creates free face for others

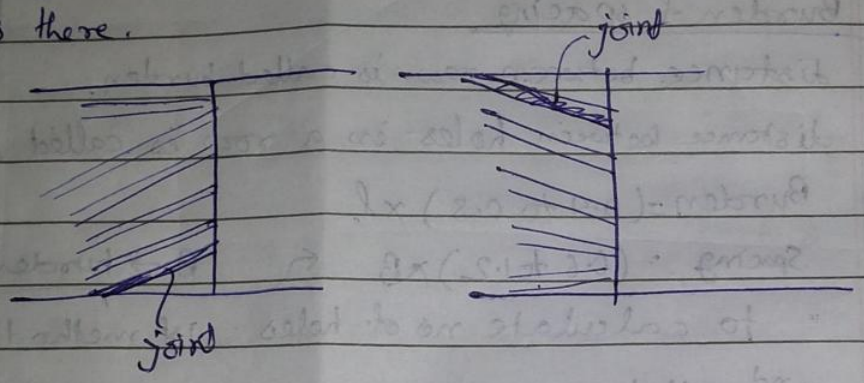
In wedge cut pattern, face advance is restricted by the size of the gallery.

Pyramid cut / Cone cut / Diamond cut

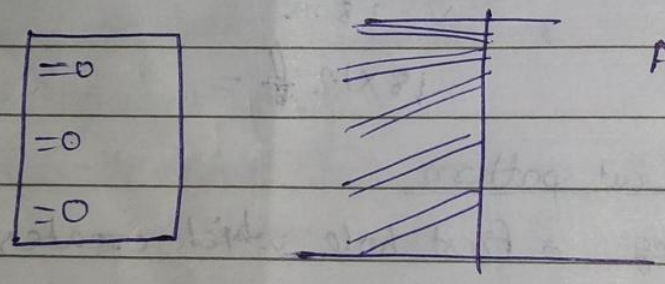


Drag cut.

Drag cut is used where joint or geological cleavage is there.

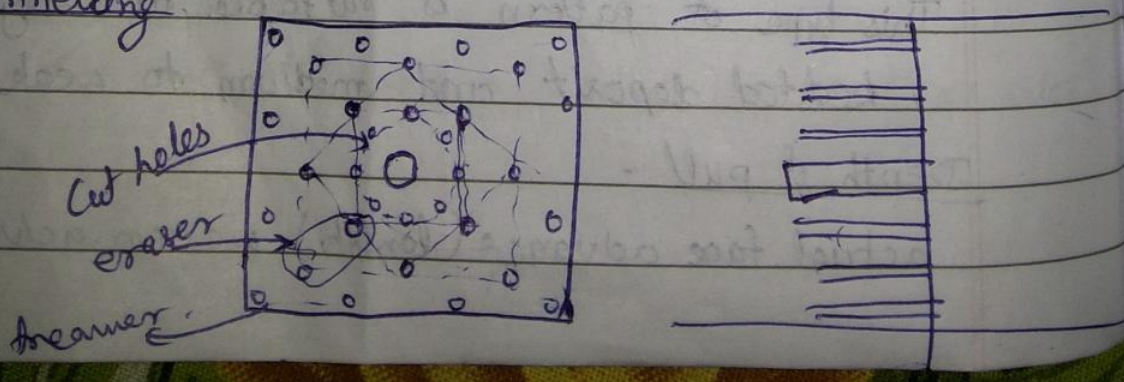


Fan cut, Over half of the wedge cut pattern and applicable in narrow ~~cuts~~ veins.



All holes are

Burn cut, Used in hard rock tunnelling



Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

ANFO is used in metal mines.
PS is used in coal mines.
Loose fragmented rock after blasting is muck.

PS →
max amt. of explosive in a hole should not be more than 565 gm in degree of gassiness II & III

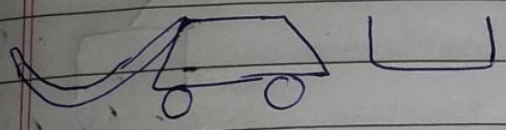
Delay

O.S.N. 31.10.18

Mucking + Loading & Transportation equipment.

- Shuttle car, LPDT, LHD, SDL
- Cavo loader, Rocker shovel
  ↳ used in only metal mines.
- Scraper

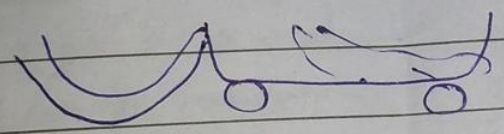
Mucking instrument (LHD, SDL
overshote, auto loaders, arm loaders, scraper,



overshot

Now a days, we don't use overshot.

Cavoloader. (Tyre mounted)



it is used to dump the material on grizzly.

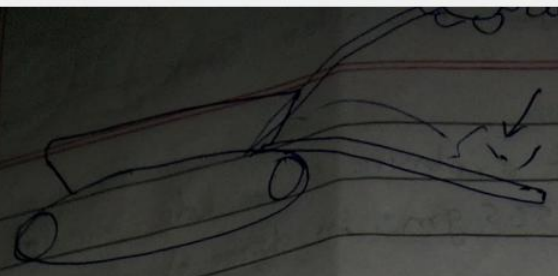
basically used in u/g metal mine.

LHD (Tyre mounted)
after loading, it moves a distance and then discharges.

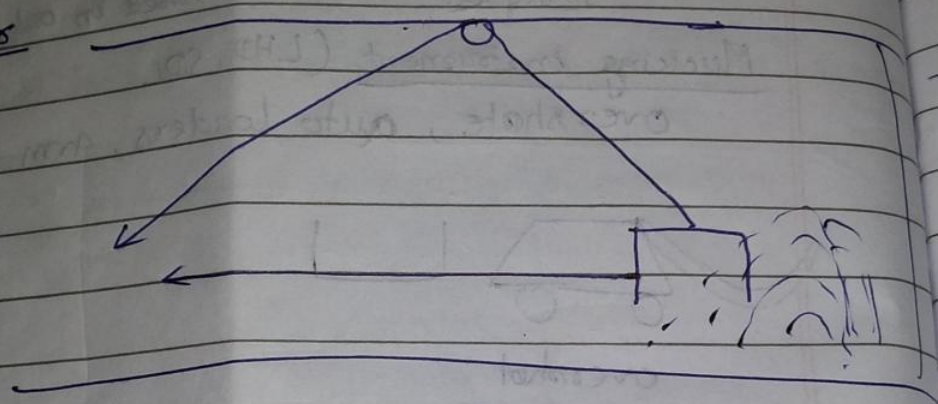
SDL (Crawler mounted)
it loads material and discharges to some other transporting medium.

Arm loader (crawler mounted)
GAM (gathering arm loader)

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in



Scraper



LHD (Tyre mounted, used in coal as well as metal mine)

~~Step~~
Shuttle

O.S.N.
1.11.13

Transport
- Haulage
  - Trackless
    - Automotive
    - Pipes
    - Conveyor
  - Track
    - Rope
    - Locomotive
- Hoisting
  - Koepe
    - Tower mounted
    - Ground mounted
  - Drum
    - Cylindrical
    - Bicylindrical
    - Conical

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

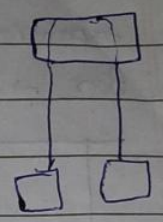
Automobiles → LPDT, LHD

In u/g mine where face can't be made we mix the water with coal through pipes

Automotive
- LPDT → 15-75 ton (capacity) average capacity → 50 ton
- LHD → 10-60 ton
- SDL car → 2-20 ton (used where height is low)
- → 10-90 ton

Conveyor
- Belt → used upto 2-4 km, used as main haulage system.
- chain → (steel) → used in rough condition

Koepe → It will worked on friction, in it both end of winding rope



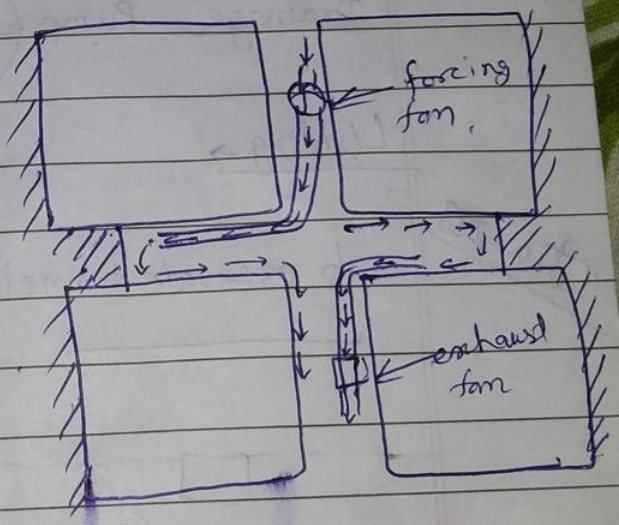
O.S.N 14.11.13

Auxiliary operation

Ventilation, support, Drainage, light

Ventilation

In blind face for ventilation, we lay the small pipe lines and install a forcing fan to force the air to the face.

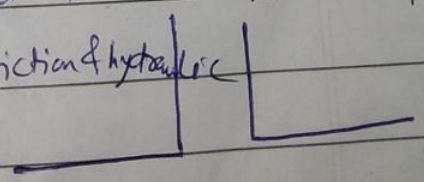


Support.

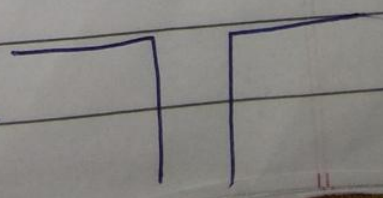
purpose → to support the roof so that it would not collapse.

Props support → wooden, steel friction & hydraulic

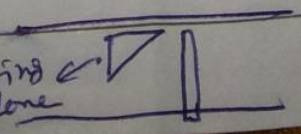
easily installed



- it gives information before collapse.



on it hammering is done

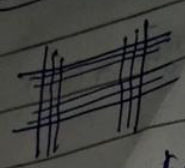


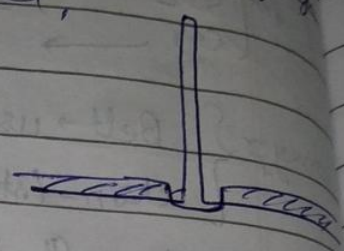
Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

(11)

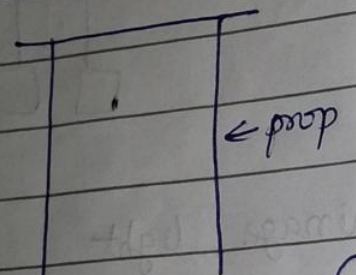
steel support
high strength but heavy

Chock & Cog → It supports high load. it is used on junction of gallery where very high support is required,





Roof/Rock bolt
→ support roof
anchoring of roof bolt
expansion all mechanism of roof bolt
Bar → It can also be inserted in roof

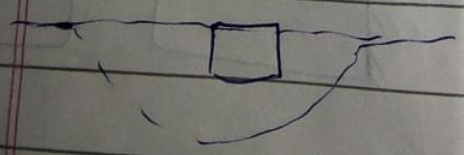


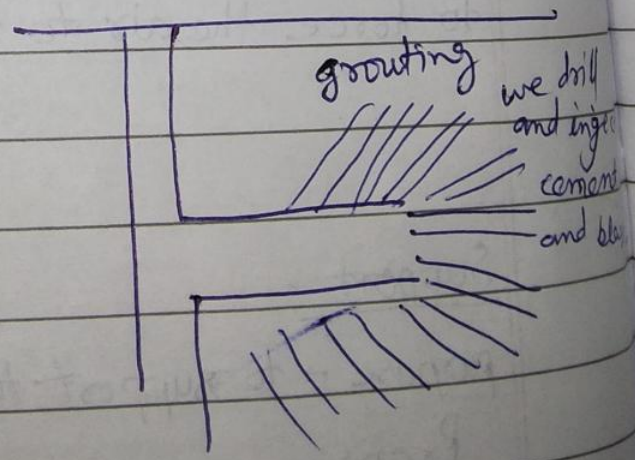
Drainage - Pump
- Sumarsible → It can directly dip into water
- Centrifugal } to pump water
- Roto → to pump mud

Lighting →

Tatia-288

to excavate tunnel below ground water table



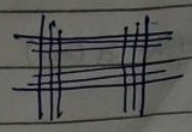


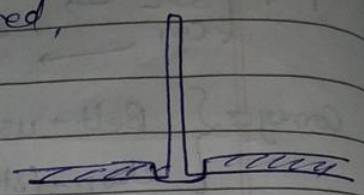
Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Steel support

high strength but heavy

Chock & Cog → It supports high load. it is installed on junction of gallery where very high support is required.





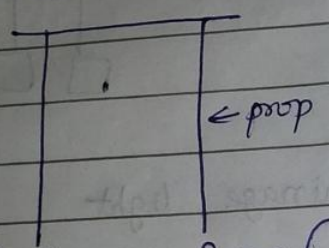
Roof/Rock bolt.

* support roop

anchoring of roof bolt

expansion all mechanism of roof bolt

Bar → It can also be inserted in roof



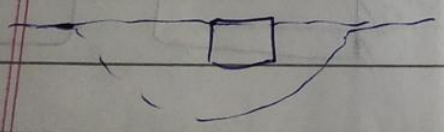
Drainage - Pump
- Sumarsible
- Centrifugal
- Roto → to pump mud

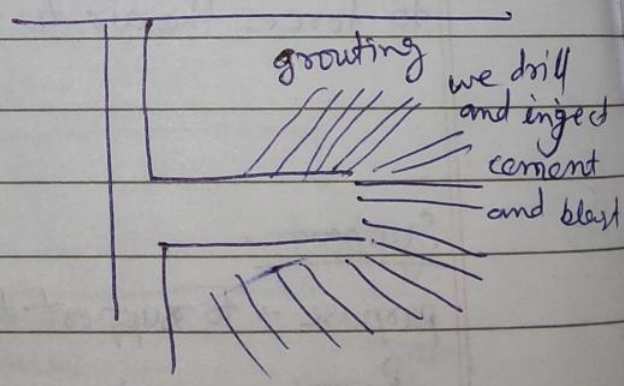
} to pump water → It can directly dip into water.

Lighting →

Ratia 288

to excavate tunnel below ground water table





Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

O.S.N.
29.7.19

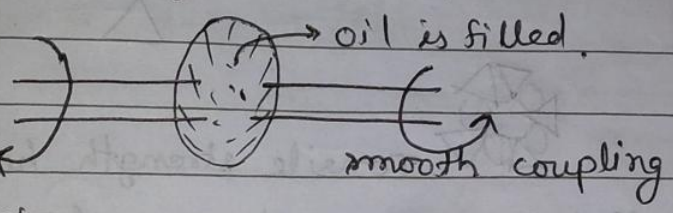
Transmission of power

Mode of transmission of power

- Coupling (Shaft coupling)

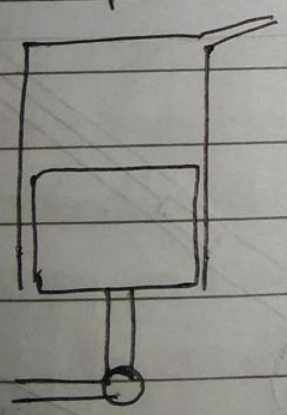
coupling
- rigid coupling (No horizontal or vertical movement of shaft)
- Flexible coupling

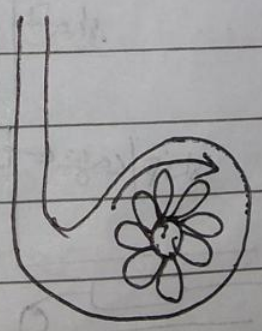
- Belt
- Chains
- Clutches
- Hydraulic transmission system
- Gears (to transmit power vertically/horizontally)
- Hydraulic coupling (100% slip no fixed coupling)



- Compressed air.

- displacement compressor
- Dynamic type compressor we increase the velocity of air.

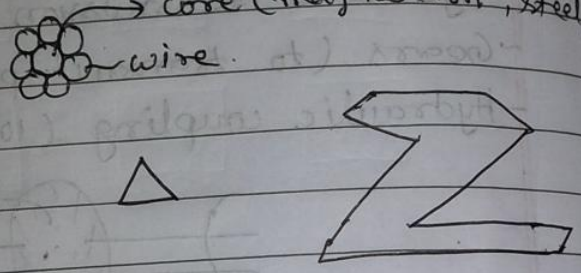


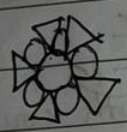


To get high amount of compressed air. we connect different compressor.

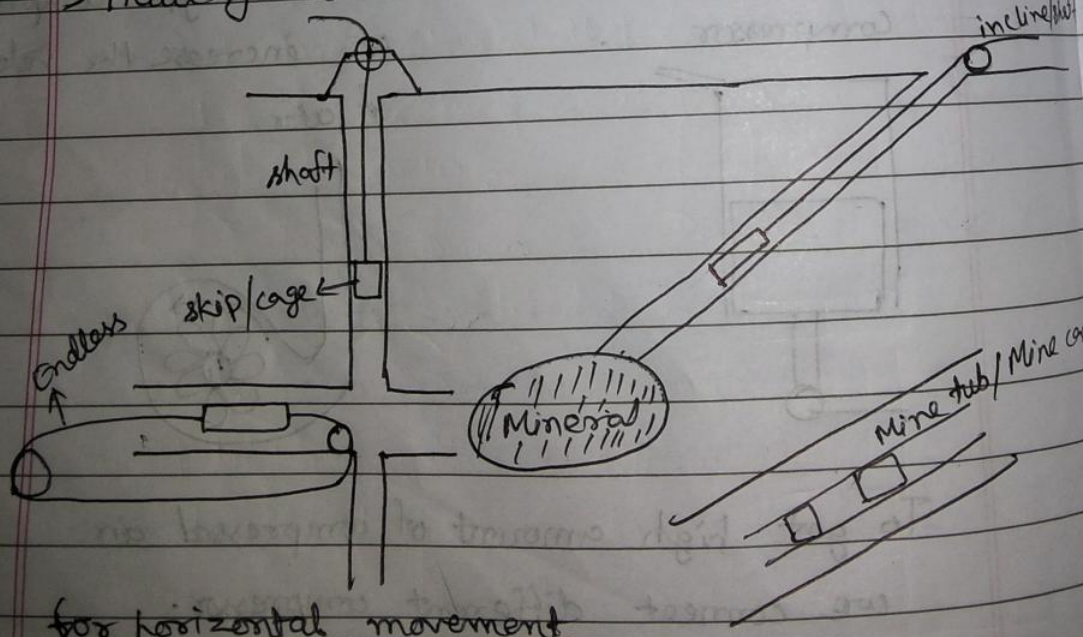
Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

→ Three types of power system
electrical, Petrol,
Compressed air (air should be dry) → used in drilling maching
drilling → to create hole below the surface
→ percussive motion is used in hard rock for drilling
→ rotory motion is used in soft rock for drilling
→ Wire ropes → to lift it is used.
to move the bucket in mining
Types of wire ropes (standing, running)
Strained wire, non-strained wire





Tensile strength high.
→ Maintenance and care of rope, copping, flying of rope, connecting two ropes.
→ Haulage (Direct, Endless, Main and tail, Gravity)



for horizontal movement
LHD, SDL

Rope haulage
and pull
four types of ha
i) Direct haulage
iii) Main and tai
Locomot

→ Rope haulage /

Rope haulage →
ropes

→ Direct haulag
of incline
Haulage is
Rope speed

→ Advantage
(i) Simple
(iii) High
→ Disadvan
(i) Freque
(ii) It re
(iii) It
(iv) D
(v) It

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Q.S.N. 5.8.13

Rope haulage - Connect the tubs by ropes and pull

four types of haulage system

i) Direct haulage (ii) Endless haulage

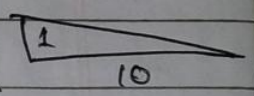
iii) Main and tail haulage (iv) Converyor belt haulage

Locomotive haulage

→ Rope haulage / Conveyor / Locomotive / Dumper / Truck
↳ For transportation.

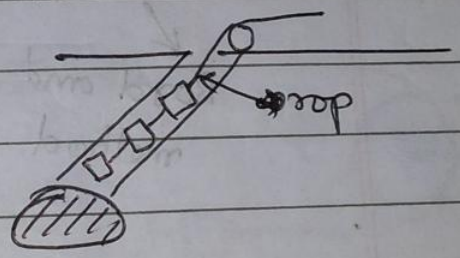
Rope haulage → Mine tubs are used for pulling by ropes. Main haulage and Gathering haulage

→ Direct haulage → Generally used when the gradient of incline is more than one in ten.



Haulage is situated at top of the system.

Rope speed is 8–12 km/hour.



→ Advantage of rope haulage

(i) Simple in operation (ii) Economical

(iii) High production (iv) Efficient in gradient

→ Disadvantage of rope haulage

(i) Frequently derailment occurs

(ii) It requires very high power requirement in starting

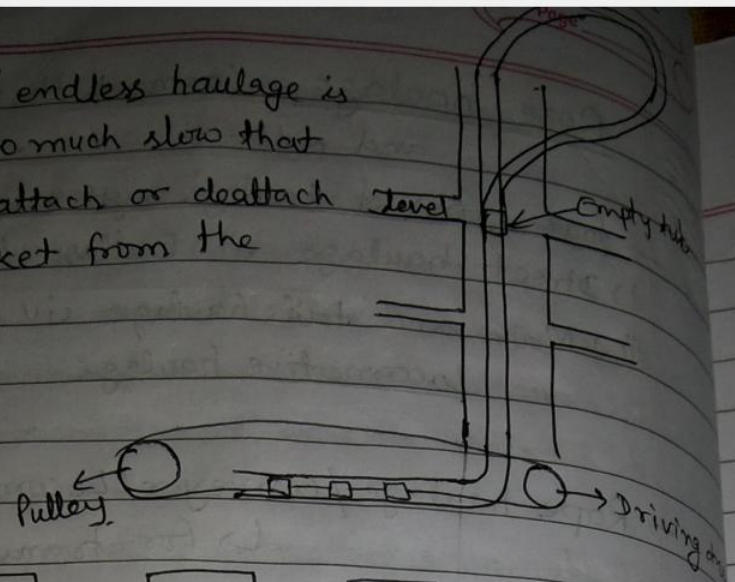
(iii) It require high maintenace.

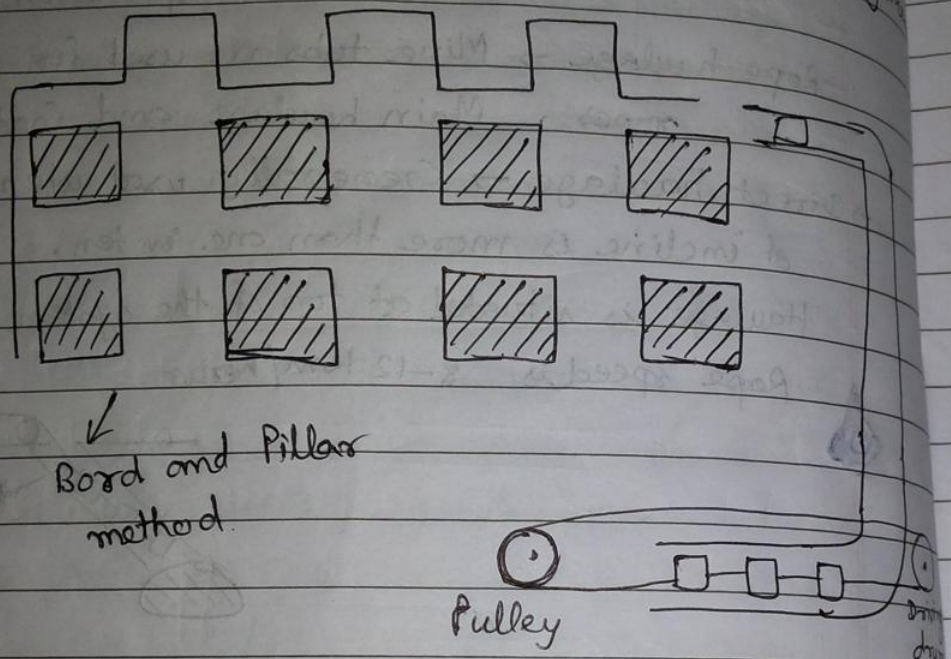
(iv) Damage chance is more

(v) It require many safety equipments.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Speed of endless haulage is slow (so much slow that we can attach or deattach any bucket from the rope)





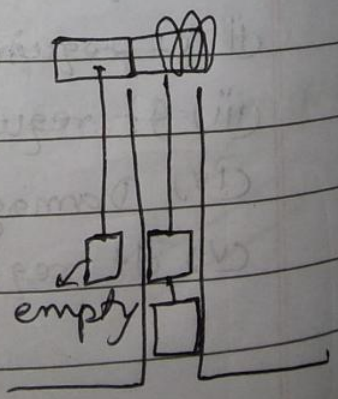
Bord and Pillar method

N.
8.19

Direct haulage - It is stalled in primary development. It is used in incline, sloping more than 1 in 7 or 1 in 10.

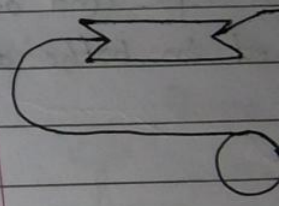
Single Drum Double drum

Double drum is modification of single drum. Double drum is used to balance the weight. So in double drum, one tub is moving inward and other is moving outward. Both drum



~~is moving~~ are mounted on same tub are balanced, is used, Where the large and requir is used where le We have to use p or triple track w be provided. In system capacity

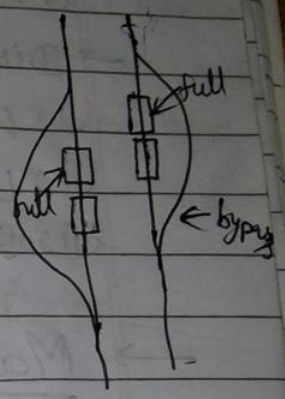
→ Endless haula



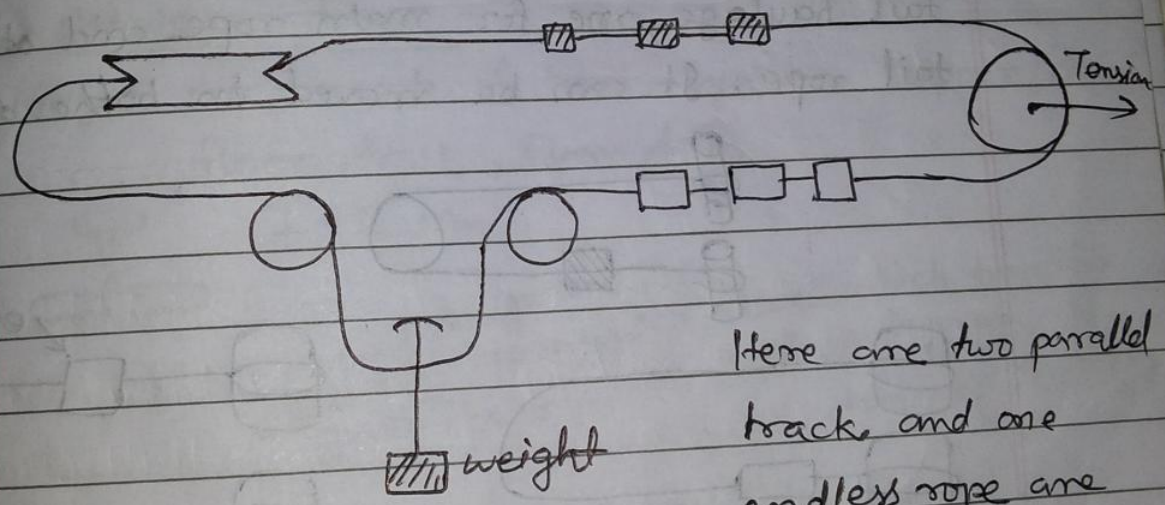
attached gradient i Rope is rope haul wire

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

~~is moving~~ are controlled by clutches and mounted on same shaft. The weight of the rope and tub are balanced. Double drum haulage system is used, Where the length of ~~kao~~ incline is very large and require a large output. Double drum is used where length of haulage system is large. We have to use power only for minerals. Double or triple track with a pass should be provided. In double haulage system capacity is double.

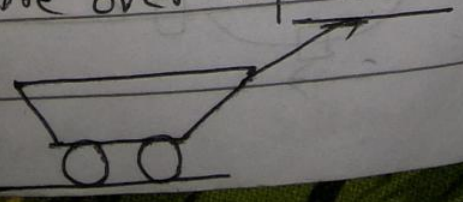


→ Endless haulage system

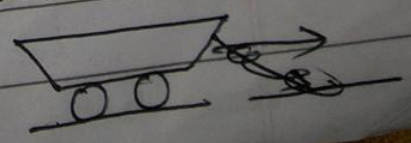


Here are two parallel track and one endless rope are attached with tub. This system is used where gradient is mild. Speed is very low (5-6 km/hr). Rope is moving in only one direction. Endless rope haulage is of two types.

wire over rope



wire under rope



Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

→ Advantage of endless rope haulage

(i) Simple in layout and operation

(ii) low speed that reduces the possibility of dust generation.

(iii) Less wear and tear of track

(iv) Less chances of accident and other damages.

(v) Regular and even flow of tubs

(vi) Less maintenance

→ Disadvantage of endless rope haulage

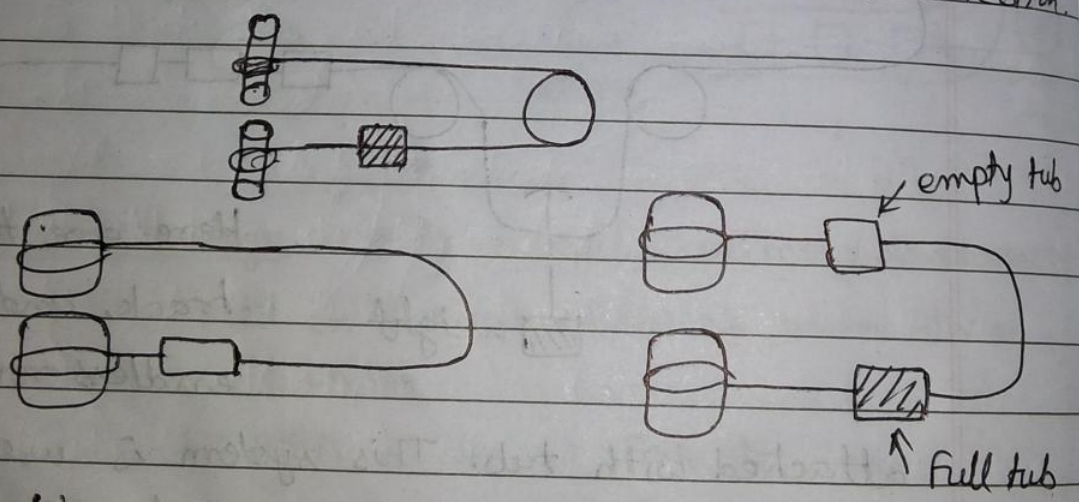
(i) Wider road or gallery is require.

(ii) Low speed, low production

(iii) It requires high man power.

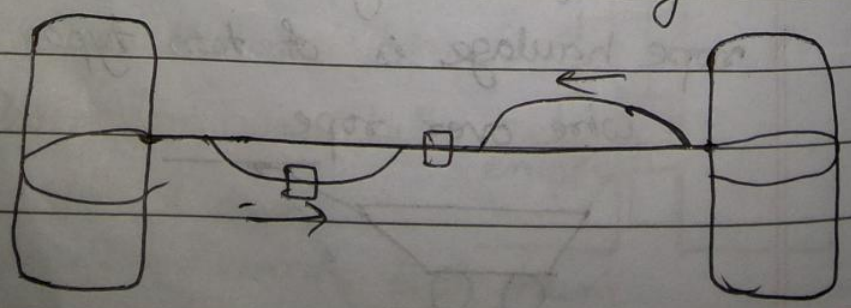
→ Main and tail haulage

Two separate drums are used in main and tail haulage, one for main rope and other for tail rope. It can be moved in bothe direction.



We can use double track or single track.

This system is used for undulating surface



Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

This type of haulage system have two ropes and increase the capacity of haulage system. ~~It requires~~ This type of haulage system is suitable for undulating road or gallery. We can operate at high speed.

→ Advantage of main and tail haulage

(i) Rapid transportation of coal

(ii) It doesn't require large no of tubs in their system

(iii) It is applicable in both level and undulating road

(iv) It can be used as a main haulage system also.

→ Disadvantage of main and tail haulage

(i) High speed, derailment frequently occurs

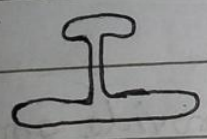
(ii) We require more ropes (excess tail rope)

(iii) It requires two drums.

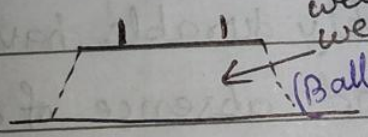
J.S.N. 19.8.13

Haulage Track

Major components of track system → Slipper, Base, floor, track, Floor of base



I - Section.



well designed well fragmented stone which transfer (Ballast) the load on sufficient area and having good drainage capacity.

Floor of base provides the base for track. It should be welded having good drainage.

→ Track consists of slipper, ballast, rail joints, rail and connecting devices

→ Track.

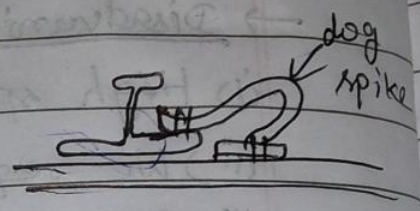
Rail must have adequate weight and cross-section

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

carry load. The section and weight of rail would depend on axial load, haulage speed, capital cost, danger of corrosion and wet condition. In general it is 220 kgf/m. The rails are usually fixed with slippers by dog spikes and are joined by fixed plate. Spike are staggered on opposite position of rail and reverse on the other rails.

→ Sometimes drill hole 3-4 mm then the spikes are inserted into the slipper.

→ To prevent rail from shifting spacial catches called rail.



→ Ballast

The purpose of this tool is to distribute an intense bearing or load on the wheel to the rails over a sufficient area of the floor, so that the safe bearing pressure on floor not exceeded.

It may behave elastic and provide good drainage. It should have highly durable having high internal friction angle and absence of any chemical reaction with slippers and rails. The size of ballast is around 20-60 mm. The thickness of ballast under the slipper should not less than 10 cm. These slipper should be buried in the ballast down to the two third of its height.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

→ Slippers

Purpose - to hold the track and transfer pressure from rail to floor.

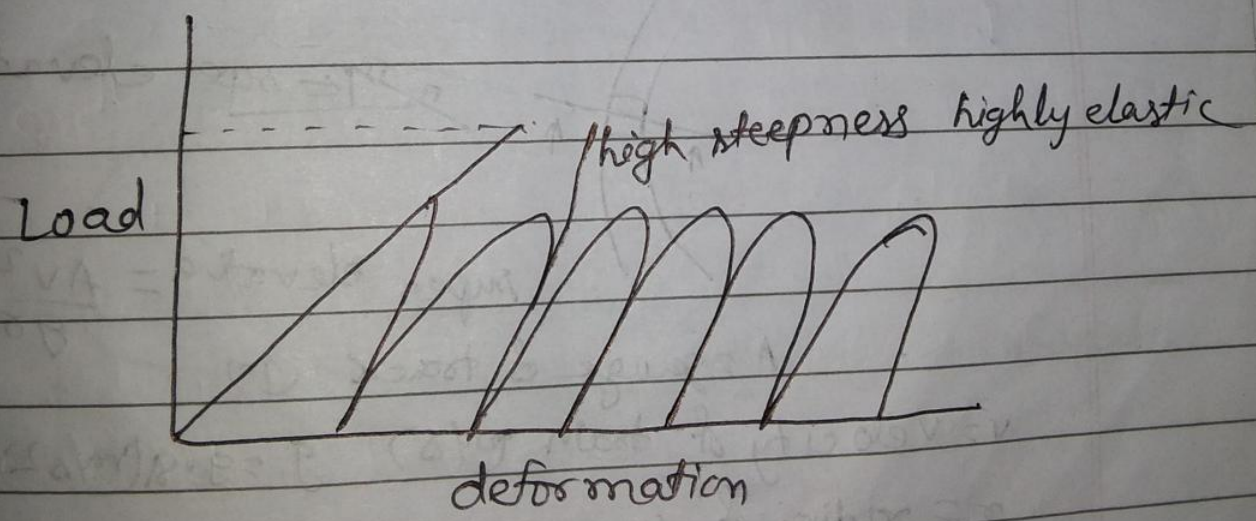
In mining wooden ~~rod~~ slipper are used.

It should be sufficiently strong, elastic and easy in treatment. It should not split even rock spikes are driven into the slippers. Wooden slippers are cheaf and easy to lay and bear. Life of wooden slippers is around 6-10 years.

The ~~wood~~ slippers are _____ high stability of tracks. It is very incise as well as nature of enforcement.

The problem with enforcement slippers :-

high weight, lack of resilience, laborious operation involving in laying and maintenance and repair of the track.



The spacing betwee slippers are 0.5 to 0.9 metres.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

→ Maintenance

Cause of distortion: due to

(i) Overload.

(ii) ~~Chem~~ Rusting or corrosion due to chemical reaction between mine water and tracks.

(iii) Large variation of temperature

(iv) Loss of proper drainage property of ballast

(v) Wear and tear of slipper due to slipping and splitting.

(vi) Wear and tear of rail joints

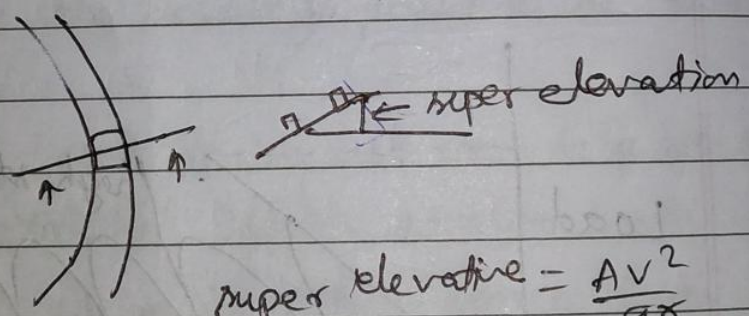
(vii) Improper fastening of rail into slippers.

→ Maintenance of track

(i) Regular inspection of tracks.

Tracks

Curves and super elevation → The min m radius of curve on which locomotives and mine car can operate



$$\text{super elevative} = \frac{AV^2}{gr}$$

A = gauge of track (m)

v = velocity of train (m/s) g = 9.81 (m/s²)

r = radius of curve (m)

Que A locomotive weighing 15 tef travels round a curve of 80 m radius at a speed of 30 kmph. If the gauge is 1 m what should be the super elevation of outer rail over the inner rail so that there is no thrust between the fl... & the outer wheels

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

and outer rails.

Ans. Super elevation $= \frac{AV^2}{gr} = 1 \times$ $V = 30 \times \frac{18}{5} = \frac{150}{18}$

TUBS & MINE CARS

Tub Capacity 1.1 m3

→ It can be unloaded manually or by a tipper.

SDL is used to load the mine tub

A mine tub is a box open the top, and mounted on a wooden frame fitted with wheel. The axle rests in a pedestal block.

Capacity :- small car, medium and large car.

Coefficient of utilization

Tare load ratio : 40-70% of total weight

Stability

Coefficient of ~~resistance~~ utilization.

Coefficient of resistance.

$$\frac{\text{Machine wt}}{\text{Machine wt + Material wt}}$$

$$\frac{\text{capacity of car}}{\text{mam}^m \text{ length} \times \text{width} \times \text{height}}$$

Construction of mine car

Granby mine car

Total resistance of mine cars consist of

Rolling, Bearing, atmospheric, gradient

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Main resistance = rolling and bearing

On incline.

$$W_{i0} = w\, G_e \cos\beta$$

$$W_1 = \pm G_e \sin\beta$$

$$W = G_e(w\cos\beta \pm \sin\beta)$$

G_e = weight of car

w = coefficient of resistance.

Choice of cars.

- Mode of unloading
- Mineral to be hauled.
- Advantage & disadvantage
- Limitation.

N. 13

Mono rail

A single track fixed on roof. It may be used to transport material and man also

two types → friction and rach and pinion

It is used in some places for transporting man and material. It is also used where excessive load - lift occurs.

For application of mono rail, the gallery height should be sufficient.

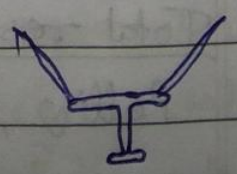
Two types of driving system

(i) Friction drive → can be applicable upto 14° gradient

(ii) Rack and pinion → can be used upto 40° gradient.

Gear (so as not slip on high gradient)

Rail guiders are fixed on the road



(i) Electrohy
(ii) Driving
(iii) Operat
(iv) Power

Advantage
- Less m
- Powere
- High
- Man

Disadva
- High
- It is
be l

Assignment
- Obje
- True
- Fi
- Or
- N

O.S.N. 10 9.13

Ques. Co

Ques 2. A

8.8 cm

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

i) Electrohydraulic power pack (Power unit)
ii) Driving unit,
iii) Operator's cabin
iv) Power supply and control unit

Advantage of mono rail.

- Less maintenance
- Powered by diesel, battery or electrical
- High availability
- Man and material can also be transported.

Disadvantage of mono rail

- High damages during derailment.
- It is stalled on some heigh. The materia has to be lifted on some height.

Assignment

- Objective (max^m 10)
- True / false
- Fill in the blanks
- One line Que / Ans.
- Numerical que / Ass.

O.S.N. 10.9.13

Que.1 Compare the applicability conditions of various types of haulage system.

Que.2 A locomotive weighing 15 tef travels round a curve of 80 m radius at a speed of 30 kmph. If the gauge is 1 m. What should be the super elevation of outer rail over the inner rail so that there is no thrust between the flanges of the outer wheels and the outer rail.

88 cm

Ans superelevation $= \frac{Av^2}{gR} = \frac{1 \times 8.33}{9.81 \times 80} = \frac{25}{3 \times 9.81 \times 80}$ $\frac{30 \times 5}{18} = \frac{25}{3}$

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Que.3. Compare various types of mine cars based on discharging system.

Q. 4. A train of mine cars of total 50 tef is attached to a direct rope haulage and is travelling down a gradient of 1 in 8, the length of haulage plane being 1000 m. The coefficient of friction of mine car is 1/50 and that of rope 1/20. The rope weight 2.73 kg/m. The radius of drum is 1m and that of brake path is 666 mm. Width of brake path is 150 mm. There is two brake blocks each having an angle of contact 90 degree on the brake path. The brake is lined with bonded asbestos with a coefficient of friction of 0.3. Find out the radial pressure to be exerted on the brake path.

Que.5. A direct rope haulage pulls 10 loaded tubs at a time up and incline-dipping at 1 in 8. An empty tub weighs 400 kgf and has a capacity of 900 kgf of mineral. Length of the roadway covered by the haulage is 500 m. The rope diameter is 25 mm. rope speed is 12 km/h. Coefficient of friction for tubs and for rope is 1/20. Estimate the power required by the rope and by the engine. Rope speed is 12 km/h.

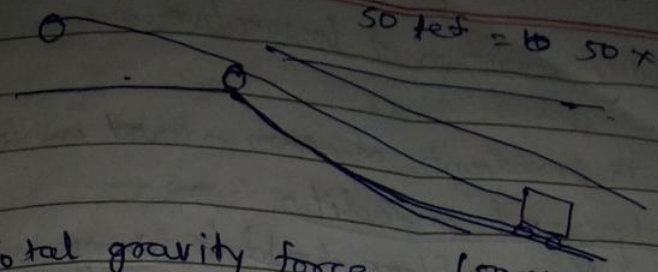
Que.6. Compare various types of safety devices used in haulage.

Que.7. Design a safety devices for haulage system for given conditions.

2. Ans $A = 1\ m$ $V = \frac{25}{3}\ m/s$ $g = 9.81\ m/s^2$ $r = 80\ m$

super elevation $= \frac{AV^2}{gr} = \frac{1 \times 25 \times 25}{3 \times 3 \times 9.81 \times 80}$

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in



50 feet = 50 × 1000 × 9.81 N

Total gravity force = (50×1000×9.81) + (2.73×1000×9.81)
= 490500 + 26781.3
= 517281.3 N

$\tan\theta = \frac{1}{10} \Rightarrow \theta = 5.710593137496$

Gravity force along incline
= 517281.3 sinθ
= 51471.3849 N

Friction force on tubs = $\frac{1}{50}$ × 490500 × cosθ
= 9761.319889 N

Friction force on rope = $\frac{1}{20}$ × 26781.3 × cosθ
= 1332.41948 N

Locomotives

It is used in metal mine. Due to its large size it can't be used in coal mine.

O.S.N. 23.9.13

i) Diesel ii) Electric locomotive (Trolly wire locomotive)
iii) Battery locomotive (iv) Compressed air type.
(v) Cable type (used for shorter distance) (100-200
Cable is winded/unwinded

Compressed air locomotive is rarely used and is used where ventilation is required and where toxic gases are present.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Applicability condition of locomotive

(i) Gradient of seam → used in low gradient. Mainly used in adit.

(ii) Types of floor → floor should be strong enough to bear the load of locomotive & material.

Capacity of locomotive is generally 20-30 tons

Used in pit bottom to collect material from face to shaft if gradient is flat.

(iii) Types of deposits → Strong for large size opening

(iv) Used when high production is required

(v) Used when distance is large area

Limitation / disadvantage of locomotive

(i) Diesel → high amount of gas produced and high maintenance is required.

(ii) Electric → Transmission line, spark

(iii) Cabel → we can't use it in long length.

(iv) Battery → we have to charge battery again and again and also we have to keep an additional battery.

(v) Compressed air → More moving parts require high maintenance.

Major parts of locomotive

(i) chasis (ii) Driving wheel (iii) Power unit (iv) Operator's cabin (v) Emergency brakes (vi) light at both end for production

Locomotive is of two types

(i) Main locomotive → no of trollies 15-20, for major production

(ii) Gathering loco → from cage to shaft, no of trollies - 4-5

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Applicability

- Where the way is gradient of the roadway is mild. Nearly flat gradient is preferred. A gradient of 1 in 15 against the loads is considered to be limit though locos are generally employed on gradient milder than 1 in 25.
- Where the loco track is in settled ground not subjected to movement by mining operations.
- Where a high standard of track can maintained.
- Large output has to be handled.
- In the intake airways, where air velocity is adequate to keep fire damp % low. If diesel loco are used the exhaust gases of the loco should be diluted by the air current sufficiently well so as to be harmful to workers.
- Roads are reasonably wide and high
- transport of mine cars involving long haul distance.

Major part of locomotive

- Chass of rigid frame work of rolled steel sections.
- Driving wheels on axles spring and brake block mounted underneath chassis.
- Power unit, diesel / electric / compressed air.
- operator cabin
- Light a both ends.
- A hand screw breakfor emergency.

Frame: locomotive frames are unique structurally sound welded frames and quality steel which is carefully inspected and specified.

- On completion of fabrication all frames are blasted in

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

35-BLC

a large chamber which removes stains.

- Wheels → All wheels are cast from a high grade of abrasion resistant steel to MTI specifications.
- Wheels are mounted via fasteners to wheel hubs.
- The wheel hubs are spline fitted to the axles to ensure the highest integrity of fit.
- Axles → Axles are designed for maximum load and are carefully manufactured from high quality alloy steel with high factors of safety. Axles are press fit and keyed to main drive worm wheels.
- Suspension → The standard suspension used by locomotives is a chevron suspension designed around parameters well known to the locomotive industry and proven in countless mine and tunnel rail haulage applications.
- Motors - The DC motors supplied are series wound and built to exacting standards with a standard base load speed of 1400 RPM.
- The motors utilized on the trolley application are designed for operation on nominal 250 volts DC input power.

→ Main haulage locomotives. Gathering locomotives

Types of locomotive.

Diesel engine → The diesel engine locomotive having higher

About engine

Specification

Safety & regulation

Maintenance (daily, weekly, monthly, quarterly & half yearly)

Battery locomotive.

About power unit

Specification

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Charging
Application
Advantage & Disadvantage

O.S.N. 27.10.13

Locomotive transport

~~Applicability~~.

~~Where the way is~~

Electric locomotive.

~~Direct current electri~~

Compressed air locomotive.

Cable reels locomotive.

O.S.N. 17.11.13

All rail property laid, no person guide rope.

Safety devices used in haulage

if length of haulage > 30 m → signalling system should be present

> 50 m → a communication system.

wires should be hung on insulators.

haulage system & manway should be seperated,

manhole should be clear and constructed on only one side,

Travelling roadway & manway

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Que 1. A locomotive weighing 15 tef travels round a curve of 80 m radius at a speed of 30 kmph. If the gauge is 1m. What should be the super elevation of outer rail over the inner rail so that there is no thrust between the flanges of the outer wheels and the outer rails.

Ans. Given data is $R = 80$ m.

$A = 1m$, $g = 9.8\ m/s^2$

$v = 30\ km/h = 30 \times \frac{5}{18}\ m/s$

$v = \frac{25}{3}\ m/s$

$$\text{super elevation} = \frac{AV^2}{gR} = \frac{1 \times (25/3)^2}{9.8 \times 80}$$

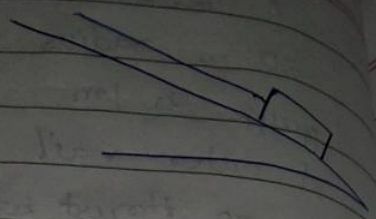
$$= 0.0885771\ m$$

super elevation $= 8.86$ cm.

Que 2. A train of mine cars of total 50 tef is attached to a direct rope haulage and is travelling down a gradient of 1 in 10. The length of haulage plane being 1000 m. The coefficient of friction of mine car is 1/50 and that of rope is 1/20. The rope weight is 2.73 kg/m. The radius of drum is 1m and that of brake path is 150 mm. There is two brake blocks each having an angle of contact of 90° on the brake path. The brake is lined with bonded asbestos with a coefficient of friction of 0.3. Find out the radial pressure to be exerted on the brake path

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Ans. Tension in the rope due to weight of cars =



$$T_1 = \frac{50 \times 1000 \times 9.81}{10}$$

$$T_1 = 49050 \text{ N.}$$

Tension in the rope due to weight of rope = T_2

$$T_2 = \frac{2.73 \times 1000 \times 9.81}{10}$$

$$T_2 = 2678 \text{ N.}$$

frictional force due to cars = F_1.

$$F_1 = \frac{1}{50} \times 50 \times 1000 \times 9.81 = 9810 \text{ N}$$

$$F_1 = 9810 \text{ N.}$$

frictional force due to rope = F_2

$$F_2 = \frac{1}{20} \times 2.73 \times 1000 \times 9.81$$

$$F_2 = 1340 \text{ N.}$$

Net tension $= (T_1 + T_2) - (F_1 + F_2)$

$$= 49050 + 2678 - (9810 + 1340)$$

$$= 40578 \text{ N}$$

Let breaking force is F

equating torque at the shaft of drum

$$40578 \times 1 = F \times 0.66$$

$$F = 61485 \text{ N.}$$

Total contact area $= 2\pi \times 0.66 \times \frac{90}{360} \times 2 \times \frac{150}{1000}$

$$= \cancel{0.471 \text{ m}^2} = 0.313 \text{ m}^2$$

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Radial pressure $= P = \frac{F}{\text{total contact area}}$

$$\Rightarrow P = \frac{61485}{0.31366} \text{ Pa}$$

$$P = 196061.862 \text{ Pa}$$

$$P = 196 \text{ kPa}$$

Que. 3. A direct rope haulage pulls 10 loaded tubs at a mine up the incline dipping at 1 in 8. An empty tub weighs 400 kgf and has a capacity of 900 kgf of mineral. Length of the roadway is 500 m. The rope diameter is 25 mm. Rope speed is 12 km/h. Coefficient of friction for tubs and for rope is 1/20. Estimate the power required by the rope and by the engine.

Ans. Mass of the rope per unit length $= kd^2$

$$= 0.35 \times (2.5)^2 =$$

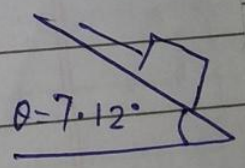
$$= 2.1875 \text{ kg/m}$$

Mass of the rope $= 2.1875 \times 500$

$$= 1093.75 \text{ kg.}$$

Tension due to tub and mineral weight $= T_1$

$$T_1 = (400 + 900) \times 9.8 \times \sin\theta \times 10$$



$$T_1 = 1580.2 \text{ N} \times 10 = 15802 \text{ N}$$

Tension due to weight of rope $= T_2$

$$T_2 = 1093.75 \sin\theta \times 9.8$$

$$= 135.66 \times 9.8 = 1329.46 \text{ N}$$

Frictional force due to weight of tub and mineral

$$= F_1 = \frac{1}{20} \times (400 + 900) \times 9.8 \cos\theta \times 10$$

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

$f_1 = 632.72 \times 10 = 6327.2\ N$

Friction force due to weight of rope = F_2

$F_2 = \frac{1}{20} \times 1093.75 \times 9.8 \times \cos\theta$

$= 531.8\ N$

Net tension in the rope =

$T = T_1 + T_2 + (F_1 + F_2)$

$= 15802 + 1329.96 + (6327.2 + 531.8)$

$T = 23990.46\ N$

Power required = Force × velocity

[illegible] $\times \frac{12 \times 5}{18}$

[illegible]

Power required [illegible]

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Tension in the rope due to weight of train

$$T_1 = 50000 \times 9.81 \times \frac{1}{10}$$

$$= 49059 \text{ N.}$$

tension in rope due to its own weight

$$T_2 = \frac{2.73 \times 1000 \times 9.81}{10} = 2678 \text{ N}$$

frictional force on rope

$$f_1 = \frac{50 \times 1000 \times 9.81}{50} = 9810 \text{ N}$$

$$f_2 = \frac{2.73 \times 1000 \times 9.81}{20} = 1340 \text{ N.}$$

Net force at the shaft of drum

$$= T_1 + T_2 - f_1 - f_2$$

$$= 49059 + 2678 - 9810 - 1340$$

$$= 40578 \text{ N.}$$

Let breaking force is F

$$40578 \times 1 = F \times 0.66$$

$$F = 61485 \text{ N.}$$

$$P = \frac{61485}{2 \times 0.66 \times \frac{150}{1000} \times \frac{90 \times 2}{360}}$$

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

c/s within lining is called the clear c/s as for any mine working to determine the excavated dimensions, the line thickness must

As explained above, dia of circular shafts in Soviet coalmine are standardized from 4-8 m at intervals of 0.5 m.

Lignite field c/s are shafts exist, ~~2950 x 5000~~ ~~3000 x 5000~~, ~~2000 x 5000 x 300~~ 2950×2000, 4000×5000 and 4000×5300 mm.

Building the shaft collar

Directly before sinking starts, a templet-frame is placed on the ground made to the shape and size of the cross-section to be excavated. The frame serves to verify that shaft is of right dimensions. The cotter or four shaft is usually built in sedimentary soil of low bearing strength. In addition, the collar usually carries the legs of the headframe and is therefore more strongly lined than the remainder of the shaft. Even if the rest of the shaft is timbered, the collar is masonry lined and if rest of shaft masonry lined, collar is thicker. To strengthen the part of shaft collar at short distance from surface, a drift is connected leading to the heating plant which warms intake air in winter. There is also another connection to the fan called fan drift and further connection which is spare.

The collar can be sunk either before or after the installation of sinking headframe and winding engine for sinking. Loose soil is dug out directly with

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

a grab, ~~hard~~ ground is broken with pneumatic picks and rocks by explosives. Water in quantities up to 10 m^3/hr at depth down to 20 m can be dealt with by a centrifugal pump ~~this~~, delivering water directly to surface.

Shaft collar is lined temporarily & permanently as same way as ~~circle~~ rest of shaft. The first frame of temporary timbering is hunged from the templ~~ate~~ frame on the surface.

At the junction with fan drift, heading, heading drift, spare drift openings are left in the lining.

The locations of holes, drilled the face depend on shape of shaft c/s and ~~lighting~~ bedding of ground. The holes in a vertical shaft are drilled with percussive drills like jack hammers. The no of holes depend on strength of ground and varies from 1 – 2/m^2 of ~~face~~ area. More holes ~~are~~ used in strong rock. Their depth recently has been from 1.5 – 4 m. The deeper hole being drilled in weaker rocks. The ~~blocks~~ blasts are fired electrically and electric current for firing is brought to face by either a cable connected ~~with~~ to the lighting ~~mains~~ main at the surface through a ~~m~~ knife switch or an exploder. In the shaft on protective stage is a two ~~pole~~ switch connected to firing cable going down to face. The loading of broken rock during shaft sinking is extremely laborious and for many years it was entirely done by hand. Now a days, digging is done by a four tipe pneumatically ~~drag~~ operated grab. Grab picks up rock

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

broken by blasting, raises it to level of hoisting bucket empties the broken rock into it and lowers the empty grab to face for refilling.

A compressed air driven winch hung from hoist raises and lowers the grab during loading. The grab is lowered during sinking and is raised by hoist to a safe height during blasting.

Four times of grab open when it is being lowered under action of pneumatic piston. During hoisting, piston rises up, closing the times of grab and lifting rock. One man controls grab by means of handle. During loading, grab is pushed into every corner of face by second man using a pole. The grab weights 650 kg. Its capacity is 0.11 m^3 and its loading cycle is 45 sec. Its output depends on capacity of sinking bucket and on character of rock being loaded. Capacity of a sinking bucket (happet, cibble, brow) may be 0.75, 1.0, 1.5, 2.0 or 2.5 m^3. With mechanised loading of rock, bucket capacity is 1.5 m^3 or more.

In the sinking of vertical shafts, bucket is hoisted by an electrically driven winding engine. for this purpose, above the shaft there is demountable steel headfram and at top of it, set on a sheave plateform are sheave carrying winding ropes.

Rope is connected to bucket by a special drawgear ensuring rapid and safe hooking on and unhooking. The shackles which holds the bail has

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

a spring head catch to prevent the bail of the bucket from releasing while it is in motion. Above the shackle, is a swivel which prevent the bucket twisting if rope twists during hoisting or lowering.

To avoid swinging of the bucket while it travels through the shaft, each bucket passes b/w two guide ropes which control its cross section. Lower end of guide ropes are connected near the face to a special tensioning frame. braced to the walls of the shaft. They are hung from sheaves at the top of the headframe and wound on to drums beside the shaft. As the shaft is deepened the ropes are wound off the drums, lowering the tensioning frame to the appropriate depth.

O.S.N.
22.10.13

Lining the shaft.

Either a permeable or an impermeable lining is installed, depending on the properties of ground, water pressure, material of lining, the and manner of building it. It must be emphasized that an impermeable lining is only achieved with the right material in the right way.

The most impermeable lining is steel or cast iron tubing used with special methods of shaft sinking.

Timber lining: Oak, pine or larch can be used for lining shafts either in the form of round timber or as slabs (round timber sawn along the heart)

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

timbering $d = 1.12 l \sqrt{\frac{P}{t_{cm}}}$ | For open timbering $d = 0.8 \sqrt[3]{\frac{a p l^2}{t}}$ cm

a = sets spaced at a cm

squared ~~block~~ baulks are also used ~~[illegible]~~ for some types of lining.

The ~~four~~ ~~is~~ essential pieces in timber lining ~~two~~ along the short side and ~~two~~ along the long side (wall plates) ~~form~~ form a frame or set.

Depending on the strength of the ground, the frames can be either in contact with each other or 0.75 to 1 m apart. In the latter case they are set on vertical props (studdles) at each corner, sometimes also along the long side. The first type is called close timbering and is used for sinking through weak ground. The second type open timbering used in rock.

Joints used are cut either as straight lap or skew lap

~~The second type open timbering is used in rock. They are cut either as straight or skew~~

~~The shaft sets are prepared on the surface and laid out as frames~~

joints of various types.

The shafts sets are prepared on the surface and laid out as frames in the order in which they will be erected underground. After careful checking and fitting, the different timbers are numbered and sent into the shaft for erection in numerical order.

The shaft lining is built upwards in lengths of 3-5 m in weak ground and 5-10 m in rock.

The first frame installed in any given length is the bearing set. It has stronger timbers, the shorter end plates projecting at both ends. These horns or projections are set in specially prepared sinking on the rock. The remaining sets are

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

built upwards on the bearing set. The space between the sets and the rock is carefully filled with waste rock. The sets are built vertically above each other and this is checked by plumb lines at each corner. The shape is checked by measuring diagonals which should be equal. The timbers should also be horizontal and checked by a straight edge and spirit level. When the sets are built on studdles (props), before the space between the timbers and the rock is filled with waste rock, the open sides are closed with tightly wedged boards called bagging.

The studdles are tenoned at each end, to fit mortises in the sets. The length of studdles is difficult to determine beforehand; they are therefore made to measure, after the last set has been placed.

As the shaft is lined it is equipped with main or surrounding beams (also called wall plates), buntons, ladder platforms and bottom.

Main beams are squared timbers, parallel to the long side of the shaft, joined to the buntons and the rest of the shaft timbering by special mortises.

Buntons (or dividers) are squared timbers built across the short dimension of the shaft and fixed to the main beams which are housed to receive the ~~buntons~~ tenons on the ends of the buntons. The main beams and buntons divide the shaft cross-section into a number of compartments (for hoisting, ladders, etc.) and stiffen the lining.

S.N. 23.10.13

~~Permanent lining of shaft sides~~

~~(Masonry lining)~~

$$d = R\left(\sqrt{\frac{K}{K-2P}} - 1\right) cm$$

~~R = clear radius of shaft (m)~~

~~K = allowable strength of masonry (km/cm²)~~

~~P = rock pressure (kg/cm²)~~

~~For central shafts are usually obtained from the following~~

Shafts in metal mines often use suspended linings built

from above downwards by using

The cross-sections of the ti

determined from end plates be

carrying a larger load, recei

the buntons and main beam

To determine the cross-

to know the rock pressure p

the shaft sets, and the le

Using the equations of

to deduce an equation f

for close timbering

K is the perm

For open timbering on

the timber diameter s

If the diamet

very large, the spa

and the calculation

Masonry l

D.S.N. 23.10.13

The thickness of

usually obtained fo

$d = R(\sqrt{}$

where R = Clear

K = allowabl

P = rock pr

The organisation

reinforced con

shaft sinking

built simult

is built in k

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

from above downwards by using the hanging bolts.

The cross-sections of the timbers in the shaft sets are determined from end plates because the long side, although carrying a larger load, receives intermediate support from the buntons and main beams.

To determine the cross-section of the timber, it is necessary to know the rock pressure P, in kg/cm², the spacing a between the shaft sets, and the length l of the end plates in cm.

Using the equations of strength of materials it is possible to deduce an equation for the diameter d of an end plate.

For close timbering $d = 1.21 L \sqrt{\frac{P}{K}}$ cm where

K is the permissible bending stress.

For open timbering on studdles, with sets spaced at a cm the timber diameter should be $d = 0.8 \sqrt[3]{\frac{aPl^2}{K}}$ cm

If the diameter obtained from this equation is very large, the spacing between sets should be reduced, and the calculation repeated.

Masonry Linings

The thickness of masonry linings for circular shafts is usually obtained from the formula

$$d = R\left(\sqrt{\frac{K}{K-2P}} - 1\right) \text{ cm}$$

where R = clear radius of shaft (m)

K = allowable strength of the masonry (kg/cm²)

P = rock pressure (kg/cm²)

The organisation of shaft lining work with monolithic reinforced concrete or segmental lining depends on the shaft sinking method, whether the lining is built simultaneously or consecutively.

With the consecutive method the shaft lining is built in lengths from below upwards. The transition

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

from sinking to lining is more complicated with masonry than with timber. Therefore, the different lengths (lifts) of lining are increased to 30-50 m or more.

Because of the danger of leaving such lengths unsupported during sinking a temporary lining is built, lagging not more than 2 m behind face.

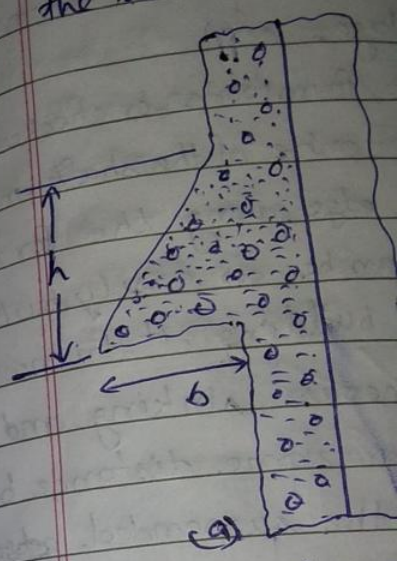
The temporary lining of the shaft consists of steel rings, usually built of channels sections, 14, 16 or 18 cm deep. The rings can be taken to pieces and consist of four to six elements depending on the shaft diameter. They are thus easily lowered into the shaft and erected.

The temporary steel rings are hung from each other by special hooks 1m long. After the rings been hung up, the space between them and the rock is packed with lagging planks.

When permanent lining is built, the temporary support rings are gradually removed. Sometimes, however in weak rocks they can't be removed and remain in the permanent lining.

The building of a permanent masonry lining starts with a kerb ring as shown in figure which is installed at a place where the rock is strong. Kerb rings take time to build and reduce the speed of sinking. Therefore, the elimination of kerb rings is now being investigated particularly because concrete bonds so well to rock.

With masonry lini
the units are la
or concrete blocks
and the concrete are
occasionally in p
masonry is check
the surface near th



Shape of ker
lined circ

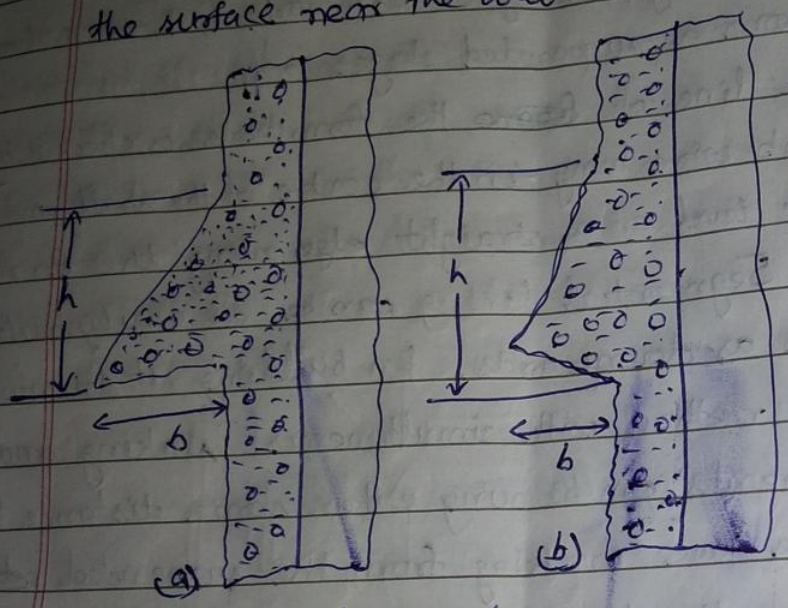
The permane
hung by rope
surface.

Concrete lin
in the shape
built from ste
in handling
to a circle.

The fram
is built on a

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

With masonry lining built of bricks or concrete blocks the units are laid in cement mortar. The bricks or concrete blocks are lowered in special containers and the concrete and mortar are lowered in buckets, occasionally in pipes. The vertical line of the masonry is checked by plumb wires hanging from the surface near the walls.



(a) single conical ring used in hard rock.

(b) double conical ring used in metallic hard or weak rock.

Shape of kerb rings in a masonry lined circular vertical shaft

The permanent lining is built from a walling stage hung by rope and operated by a slow-speed hoist on the surface.

Concrete linings are cast behind wooden or steel forms built in the shape of the shaft cross-section. Steel framework is built from steel ribs covered with steel plate. For convenience in handling the forms are made in segments, four to six to a circle.

The framework is usually 1 m high. The first form built on a special wooden platform in the face for forming

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

the kerb rings. The segments are bolted together.

Behind the framework the sinkers place the concrete compacting it with pneumatic rammers or vibrators. After the space between the rock and the framework has been filled with concrete, a second ring of formwork is built above the first and so on. Concreting, placing of formwork and removal are done from a suspended stage.

The line of the formwork is checked by a plumb wire hung in the centre of the shaft and by a spirit level on a straight edge along the forms.

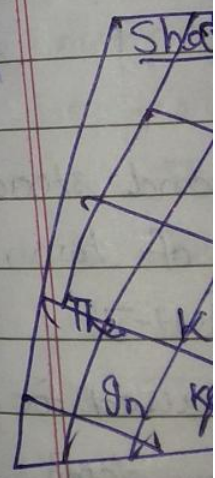
Segmental lining can be as easily built upwards as downwards. In building it downwards, the usual method with simultaneous sinking and lining the segments can be hung either some distance back from the face working from the suspended stage, or directly in the face as the rock is cleared. With the latter arrangement, the permanent lining is only 1 to 2 m behind the face and there is no need for temporary lining.

With a reinforced concrete segmental lining, particular care needed in maintaining the outline of the shaft because with reduction of the diameter the segments cannot be inserted and extra work has to be done to fit them in. Increase of the excavated section involves increased grout between the rings and the rock.

Reinforced concrete segmental linings are made to standard shaft dimensions and may be smooth or ribbed. Ribbed reinforced concrete segments for a 4.5 m diameter shaft, seven in which make up a complete ring and

each segment
Segments can b
The segments
by electric loco
spreader bean
In the f
into place b
which it fi
To make the
horizontal
Until recen
with kerb
rock has
Equ
a masonry
is not si
shaft, but
lined. T
left for
left, hole

O.S.N.
29.10.13



and
brac
from

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

each segment weighs 900 kg.
Segments can be made with a smooth outer face.
The segments are brought to the shaft on trolleys drawn by electric locomotives and are lowered by special spreader beams on the hook of hoisting rope.

In the face or from the stage, the segment is pushed into place by two or three sinkers to the position from which it finally hangs.

To make the lining impermeable, all the vertical and horizontal joints are caulked with expanding cement. Until recently, segmental linings have been built with kerb rings, and the space between them and the rock has been grouted with cement-sand mortar.

Equipping the shaft is more complicated with a masonry lining than with a timber one. Equipping is not simultaneous with lining as in a timber-lined shaft, but subsequent, when the whole shaft has been lined. The ends of the buntons are built into pockets left for them in the lining. If no pockets are left, holes have first to be made for them with a pneumatic pick.

~~Shaft sinking Machines~~

~~The KC-I & KC-II~~

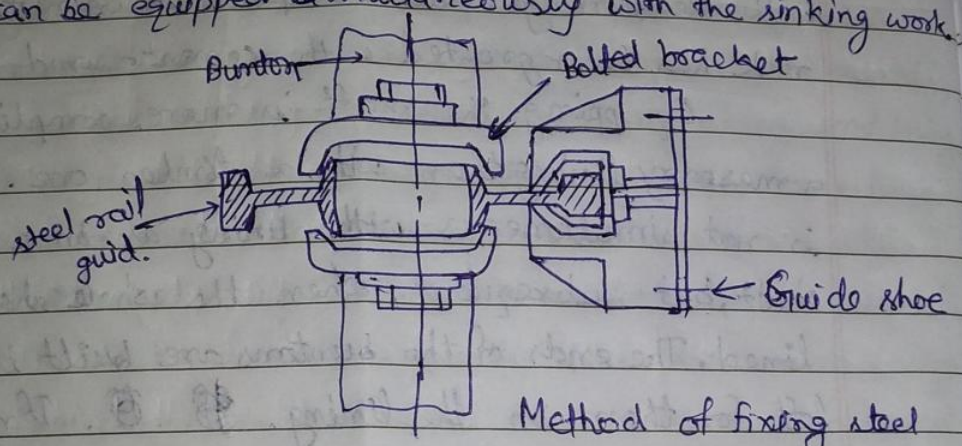
~~In KC-I & KC-II~~

With masonry linings, the buntons are usually made of I-sections 20 cm and 36 cm deep. The guides can be either wooden or steel. Steel guides are made of railway rails, weighing 38 kg/m and 135 mm deep, fixed to the buntons by special brackets as shown in figure. The buntons are fixed from the top of the shaft downwards by men on the two-

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

deck suspended stage. The distance between the top and bottom ~~decks~~ decks is equal to the vertical spacing of buntons, so that the lower deck can be used for forming the holes while on the upper deck, the buntons are set in them. When the stage reaches the shaft bottom, it is dismantled and sent to the surface in pieces. After the buntons have been fixed, the men in the shaft work on specially suspended cradles from the top of the shaft to the bottom.

The correctness of the setting of the buntons and the guides is checked by templets. Deep verticals shafts can be equipped simultaneously with the sinking work.



Method of fixing steel guides to rolled steel joist buntons.

O.S.N.
29.10.13

Shaft sinking machines

To achieve full mechanization and steady high sinking speeds, shaft sinking machine of two main types are used, are called sinking outfits or complexes (i) KC-1, KC-2 (ii) KH-7

The KC-1 and KC-2 outfits are used for sinking vertical shafts 7.5 m in diameter to any depth exceeding 200 m, at a designed speed of 200 metres/month. In these outfits, loading at the face is mechanised,

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

so are the tipping of the buckets at the surface, the erection of the permanent lining, the pumping and all subsidiary work. There is no need for temporary supports.

The KC- outfits require three winding engines of 650 - 850 kW, two for rock, and one for lowering materials, and a set of slow-speed sinking hoists with centralized remote control.

The buckets which are automatically tipped at the surface, have the capacity of 3.3 m3

The KC-1 is used for shafts with linings of concrete cast in place and the KC-2 for precast segmental concrete linings built simultaneously with the shaft sinking, using the first deck of the suspended stage for fixing the segments by hanging.

The KC-1 consists of a tensioning deck, a lowered shield which is 15.4 m high and fulfils the function of the temporary lining, the jib cranes carrying the grabs of 0.25 m3 capacity, a four deck suspended stage and two komsomolets horizontal pumps for pumping the water from the tank to the surface or to the first intermediate sump in the shaft.

The complete outfit of cylindrical shield and suspended stage weighing 96 tons is hung on six ropes which act as guides for the sinking buckets.

The height of the suspended stage is 13 m and it weighs 47 tons. It carries sliding steel frame-works which is 1.8 m high, also hydraulic Jacks and vibrating trough for placing the concrete behind the frame works.

The fourth deck is protective. Before the face is blasted, the grabs

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

are withdrawn to the tensioning deck and their jibs are folded and covered with special protective covers. To reduce the amount of time spent on subsidiary works, the sinking buckets are not unhitched.

The KC-1 outfit was tried at the Donets coalfield for sinking a skip-hoisting shaft and KC-2 was tried at the same mine for cage-hoisting shaft.

The full scale tests of the KC-1 showed its disadvantages, some of the main ones being listed below.

(1) With grabs fixed on the cylindrical shield the guide ropes were pulled out of position relative to the bellmouths of the suspended stage, and even minor skewing of the cylindrical shield disturbed normal working.

(2) The great height of the suspended stage necessitated accurate levelling of the deck. With minor off-levelling the buckets did not pass through their bellmouths.

(3) The device for mechanically placing the concrete behind the formwork was unsuccessful.

(4) the cylindrical shield was hung on six guide ropes passing through bellmouths in the four decks, involving careful centring of the ropes and the bellmouths, which occupied up to three hours.

The KC-2 has a cylindrical shield 8 m high, weighing 339 tons, hung on three ropes. The rock is loaded with two compressed-air operated six-tine grabs of 0.38 m^3 capacity, with power operated horizontal motion, controlled by drivers in cabins.

The suspended stage of the KC-2 outfit is 10m high and three decked. The bottom deck carries the hopper for

grout, and the pump
from the tank, betwee
water is pumped i
turbine pump in
Under the botto
compressed air
The precast
erected by hongi
on the ring-sh
with the men
first deck, bel
- The suspen
56 tons is h
Before bl
lifted some
The KC
equipment
at the s
interlock
the stage
with
directl
The
Organ
Shaft
whol
des
i)

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

grout, and the pumps which pump out the water from the tank between the first and second decks. This water is pumped into the tank by an H-1 compressed-air turbine pump in the face.

Under the bottom deck is a ring monorail carrying compressed air driven trolleys (telphers) for the grabs.

The precast reinforced concrete segments are erected by hanging using the two telpher hoists travelling on the ring-shaped monorail under the middle deck, with the men working at erection standing on the first deck, below it. The top deck protects the men beneath.

- The suspended stage with all its equipment weighing 56 tons is hung from one central rope and six guide ropes.

Before blasting the stage with all its equipment is lifted some 20-25 m above the face.

The KC-2 outfit is supplied with special signalling equipments, telephones, and lamps, with counterweights at the surface for tensioning guide ropes, and automatic interlocks to allow the sinking buckets to pass through the stage into the face.

With the KC-2 outfit all pipe lengths are fixed directly to the shaft lining.

The maximum output of the KC-2 grabs is 60 m³/hour.

Organization of shaft sinking

Shaft sinking ~~contributes~~ constitutes without interruption the whole year ground in four six hour shift per day. The three main types of work are i) Sinking proper ii) Lining iii) ~~Equipping~~ Equipment of the shaft.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

operation	Duration per cycle hr	Duration per cycle min
owering men & tools	0	10
laking safe in the face	0	10
Loading rock	3	40
Drilling	1	40
isting tools & lowering explosives	0	10
harging the holes	0	35
d of shift, preparation the face for blasting	0	15
learing smoke	0	10
anging segments, ointing, grouting hind the supports	5	15

O.S.N.
30.10.13

In rectangular shaft with timber lining all these tasks can be simultaneous. In circular shafts with any type of masonry lining, they can be done either consecutively or simultaneously.

Sinking involves following consecutive tasks :-

drilling in face, loading the holes, blasting, ventilating the face and making it safe. After blasting, loading the rock, building the temporary lining, building the permanent lining and subsidiary work necessary for the main purposes.

These tasks form the complete sinking cycle. At every cycle the face is deepened by useful length (the pull) of the hole about 0.8-0.9 of their length and the work repeats in the same sequence. One cycle may be completed per day.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

If one cycle is completed in two days, it would be described as half cycle per day, if three cycle are completed in two days, this is one and a half cycles per day.

Knowing the pull of the hole and the no of cycles per day, we can determine the daily rate of advance. For e.g. Let the pull be 2 m for one cycle per day, there will then be advance of $2 \times 1 = 2$ m per day. This is easily converted to a monthly rate of advance.

The cyclic organisation of the work is expressed in special charts, one of which is shown in the figure, drawn up for the sinking of ventilation shaft of Glubokaya mine, it achieved the record sinking speed of 241.1 m/month.

This shaft has a diameter of 7m inside the lining (8 m excavated) and a designed depth of 1016 m. The mine is subject to sudden outburst of coal and methane, and for gas and dust conditions, it is worse than the worst class. The coal dips at 6-8°, Water amounting to 20 m^3/hr. caught in two water rings was pumped to the surface. In the face itself the inflow amounted to 6 m^3/hr.

It was pumped by a centrifugal pump into a sinking bucket and hoisting to the surface. A sinking outfit is used with five loading grabs. The rock buckets were of 2 m^3 capacity and there were two single drum hoists and one double drum hoists. The materials for permanent lining were lowered to the suspended stage (by a

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

fourth (single-drum) hoist in 1.5 m^3 buckets. The rock from the shaft was taken in dumping lorries to the dumping yard 1 km away. There were 132 men altogether, 88 sinkers in the pit bottom and 44 men building the permanent lining. Every shifts 19 sinkers were lowered to bottom. The cycle begins with sinking the face and loading the rock blasted in the previous shift. Each grab was served by two sinkers, Hitching and unhitching the bucket occupied 4-5 men, 3 men for signalling and 1-2 men were removing rock. As the rock was cleared, the drills started work. Drilling holes 56 mm in diameter and 2.5 m deep.

The explosive used was 62% dynamite in cartridges 45 mm in diameter. The holes were charged by 14 men who held the shotfirers certificate. The explosive consumption was 1.2 kg/m^3, and 87% of the length of the holes was pulled. The permanent lining was built by 9 men per shift, 7 men hanging the segments 1 man making the joints between them & one man grouting the space behind them. The space behind the segments was grouted in lifts of 15 rings of segments at a time. The sinking of glubokaya ventilation shaft was the first shaft at which segmental concrete lining was built without a kerb ring.

So as to pluck the 15th ring of segmental concret

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

lining, ~~bolts were~~ boards were placed under it. The cracks were covered with ~~ta~~ paper, over which a layer of 20-30 cm of sawdust was pressed d with a course of brick, all placed through an opening made in the lining. This opening was then bricked up and the space was filled with grout from the walling stage.

The first 3 metres of each lift of grout were made with quick setting mortar of 1:1 mix, with 5% calcium chloride added.

Nothing left

The remaining 12 m were made with 1:1.5 grout. The driving speed is the main criterion of the correctness of the method of shaft sinking from the viewpoint of the fulfilment of ~~method~~ the different operations and of the whole cycle. Because of the improvement in driving and in organisation, there has been a steady ~~speed~~ increase in sinking speeds. All the ~~Although~~ main equipment for sinking large shafts is now hung on ropes. This method of work greatly eases the various tasks connected with extending the pipes, lowering the pumps and so on, but requires a corresponding no of hoists and space for them around the shaft at surface. In planning the location of all temporary structures necessary for sinking, the aim should be to site them where no permanent engineering structure will be built in the future. In this way the mining work and building work need not interfere with each other.

Apart from the sinking of shafts

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

from stages hung on ropes standard designs have been worked out for simultaneous sinking, lining and equipping of shafts. With this method the sinkers use the permanent headframe and for shallow shafts, also the permanent winding engines. The temporary hoists carry on the ropes only the stage and the emergency ladder. All the remaining equipment is fixed on the permanent lining. The permanent buntons also carry the water tanks for the water pump from the face and the pumps lift it to the next level.

The permanent lining whether of segmental or monolithic concrete is erected from the lower deck of the suspended stage with the cylindrical shield firmly attached to it. The organisation of work is one cycle per shift with a pull of 1.1 m per shift. After each cycle, the suspended stage is lowered with the cylindrical shield by the length of pull. The buntons are built in top deck of the suspended stage at a vertical spacing of 3125 mm. The ladder compartments are started at the same time.

Wooden guides 6.25 m long are fixed to four buntons and steel guides 12.5 m long are fixed to four buntons. No other work is done either in the face or from the suspended stage while the guides are being fixed. The advantages from the simultaneous equipping and permanent lining of a shaft include

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

fewer sinking hoists, the length of ropes needed for hoisting the shaft equipment is approximately a quarter of that otherwise needed, the overall development period is shortened and the cost of sinking is reduced. Plans are now being made to increase the spacing of the buntons and thus also the lengths of guides installed on them.

Special Methods of shaft sinking

Shaft sinking in waterlogged ground involves special methods, quiet different from those used in ordinary ground. The complicating factors are, the quantity of water and instability of ground. Sometimes these factors are separated but if they occur together, this creates particularly difficult conditions for sinking. Basically, all difficult sinking conditions fall into two groups.

(i) Sinking in waterlogged or unstable ground, quicksands

(ii) Sinking in strong but very porous & fissured rock containing large quantity of water.

Most complicated condition occurs when water is under pressure.

The special method of sinking is divided into three groups.

(i) enclosure of the face and its protection from unstable ground & water by special lining ahead of face : Sheet piling, use of a drop-shaft, sinking the face under compressed air.

(ii) Temporary or permanent isolation of water from

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

rock ~~fo~~ where shaft is to pass: artificial freezing, cementation or grouting, chemical consolidation, artificial lowering of ground water.

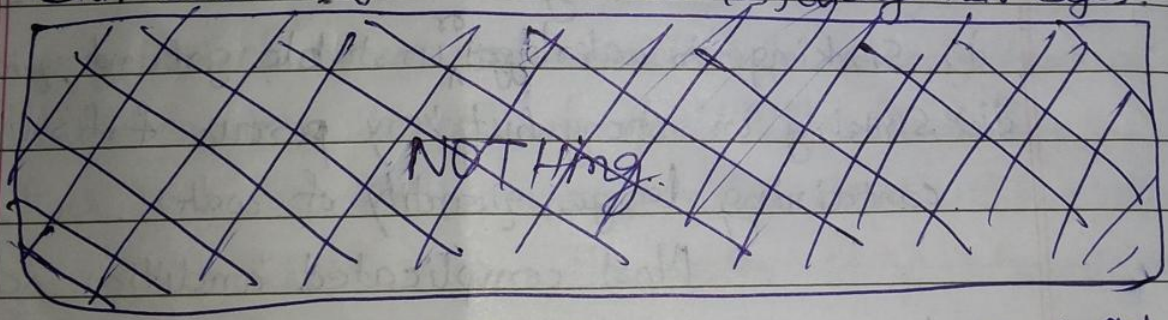
(iii) Sinking the shaft by drilling it

In strong water bearing rock, cementation can be used as well as freezing, drilling, ground water lowering and driving under compressed air but the main method is cementation.

In quick sands all methods are used except cementation.

Fore poling and steel sheet piling

Sheet piling enables a shaft to be sunk through shallow, friable or non-cohesive ~~[illegible]~~ ground which is not very thick. Around the rim of the shaft excavation in the loose-soil, wooden boards (forepoles) or steel sheet piles are driven down, held in contact with each other by grooves (or clutches) along their edges.



Fore poles are pine or oak boards 2 to 6 m long, 50-100 mm thick, 150-200 mm wide, and they are started from 1 to 1.5 m above the quick sand. To direct them and prevent their being pushed into the shaft, they are laid outside guide rings placed for them. They may be driven vertically or askew. The fore-poles are then described as either as vertical or inclined.

With vertical fore poles, shaft c/s is

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

gradually reduced but the piles can be driven mechanically. With inclined fore poles, shaft maintain c/s but the piles must be driven by hand. As the fore poles are driven in, only so much ground is excavated as to leave enough to prevent the forepoles from being forced into the shaft. The permoment lining is built inside the forepoling as it progresses.

Steel sheet piling is made of rolled steel sections of special shape.

Fore poling is the most ancient method of sinking through quicksands but it is unreliable and required highly experienced sinkers. Fore poling is now a days used for, quicksands not thicker than 2m and without water under pressure.

Steel Sheet piling can be successfully used through large thickness of shallow quicksand (8-10m) provided that there are neither boulders nor loose stones larger than 6-8 cm long. For steel sheet piling be successful, there should be an impermeable bed not less than 1m thick beneath the quicksand. The toes of the sheet-piles are driven into this bed.

Steel sheet piles are most easily driven for a circular shaft. To maintain verticality, shaft collar is first built, and withing it an inner and an outer guide ring are laid 0.8-1.0 m apart. The shee piles are driven by vibrators or by steam hammers.

The ground is excavated after the piles have been driven and during excavation at every 0.7-1 m vertical distance, circular walings are

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

set against the sheet piles to resist the ground pressure.

After excavating the pit sand and deepening the sand into the underlined rock and permanent masonry lining is erected on it. are left in

In 1947 when used for sinking.

(i) Central mine of donet's coalfield. - The vibration reduced the internal friction between the particles of soil and increase the speed of penetration

Double tube piles with water. them were used in consumption with sheet piles.

Whenever the sheetpiling four poles are used care must be taken that during dewatering, large quantity of silt or sand are not removed. If this occurs, large cavities may be formed in the surrounding ground

Drop shaft

A drop shaft is a lining for a vertical shaft which seems under own way or under external load (forced lowering). Drop shafts are used now a days to sink upto 25 m deep through friable shaft flowing soils 8-10 m thick with inflows of water upto 15 m^3/hr and without hard , large boulders are

There should be impermeable ground withing the friable soil of the drop

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

shaft can fell itself.

The drop shaft consists of two parts, the cutting and above it the walls. The cutting cuts through the ground at the foot and eases the lowering of drop shaft by ground. The c/s of a drop shaft can be of any shape but it is usually circular. On starts with the building of the shaft collar. In the floor, a concrete mattress, 100 - 150 mm thick is ; for a layer of crossed on which the segments of cutting are assembled.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

3/

Pneumatic shaft sinking

For shaft singking through quicksand containing water under-pressure, conventional methods are unsuccessful and shaft has to be sunk under compressed air. The compressed air withing the shaft passes the water back into the surrounding soil mass, strengthening it and keep it dry. The shaft is sunk with either a sinking a stationary working chamber (one with a stationary deck). Sometimes both methods are used, sinking begins with a moving chamber and ends with a stationary one. Usually the deck of the working chamber is stationary.

Communication with the surface are through air locks built in pipes.

Air locks allow men, material and rock to pass through them without adversely affecting the men's health or the continuity of the work.

In the 3m diameter shaft there is one two-stage man-lock and one-material lock. In the 4.5m dia shaft there are two two-stage man-locks and one material lock. In a 6m dia shaft there can

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

Shaft

The freezing method consists in the formation of a ice cylinder in and around the shaft to be sunk, within which the shaft can be sunk by the usual methods.

Boreholes are drilled round the shaft to a slightly greater depth than the intended depth of freezing. The diameter of the circle on which these holes are placed, depends on the thickness required in the ice wall to give it the necessary strength to resist the pressure of the quicksands throughout the period of sinking; for circular shafts, the thickness E in metres is obtained from formula

$$E = R\left(\sqrt{\frac{C}{C-2P}} - 1\right)$$ where

R = excavated radius of shaft (m)

C = permissible compressive stress of the ground at freezing point (kg/cm²)

P = ground pressure against th frozen wall (kg/cm²)

The diameter of the circle on which the holes are

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

placed will be $D_1 = D + 0.6E$ where

D = excavated diameter of shaft (in m)

E = thickness of the ice wall (m)

0.6 = a factor which takes account of the quicker freezing of the soil within the shaft.

The bore of the inner tube is 25-50 mm, the outer tub having a 100-114 mm bore. With this ratio of diameters, the cooling liquid quickly reaches the foot of hole without appreciable heat gain and rises slowly thus ensuring good heat transfer from the surrounding ground.

The low temperature required for freezing the ground are achieved in refrigerating liquid of low boiling point and vaporizing it. The transformation of a liquid into vapour is accompanied by the absorption from the surroundings of the heat needed for its vaporization. ~~Ale to the~~ According to the pressure at which vapour is formed, extremely low temperature can be reached and the solution pumped into the freezing tubes can thus be cooled by the vapour.

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

The temperature of the brine is lowered at the spiral tube of the vaporizer in which the refrigerant boils.

For shaft sinking, the commonest refrigerating plants use ammonia which cools brine to $-25°C$ and enable the ground to be frozen at temp from -12 to $-18°C$ which is usually quite adequate.

In CO_2 refrigerating plants, the refrigerant cools to $-50°C$. These are used for the freezing of groundwater in rapid movement, or for groundwater containing dissolved salts which lower its freezing point. A ground temperature of $-25°C$ can be achieved with CO_2 plants.

The ground around the different holes can be frozen simultaneously or consecutively. With simultaneous freezing,

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in

the brine is pumped simultaneously into all the holes in the consecutive method it is first forced into two ~~all the holes in~~ diamotrically opposite holes.

The consecutive method of freezing process consists ~~of~~ in the formation of a closed ice cylinder at the required temperature. It is identified, on the one hand, by the incoming and outgoing brine temperature and the brine quantity flowing, which enables the heat flow from the ground

Call/Whatsapp-8804777500 www.MINEPORTAL.in www.fb.com/mineportal.in