Mine Shaft

What is a Mine Shaft?

- A mine shaft is vertical or inclined opening, giving access to and serving the various levels of a mine.

- It is a primary vertical or near-vertical opening, connecting the surface with underground workings.

Stages in the life of a mine

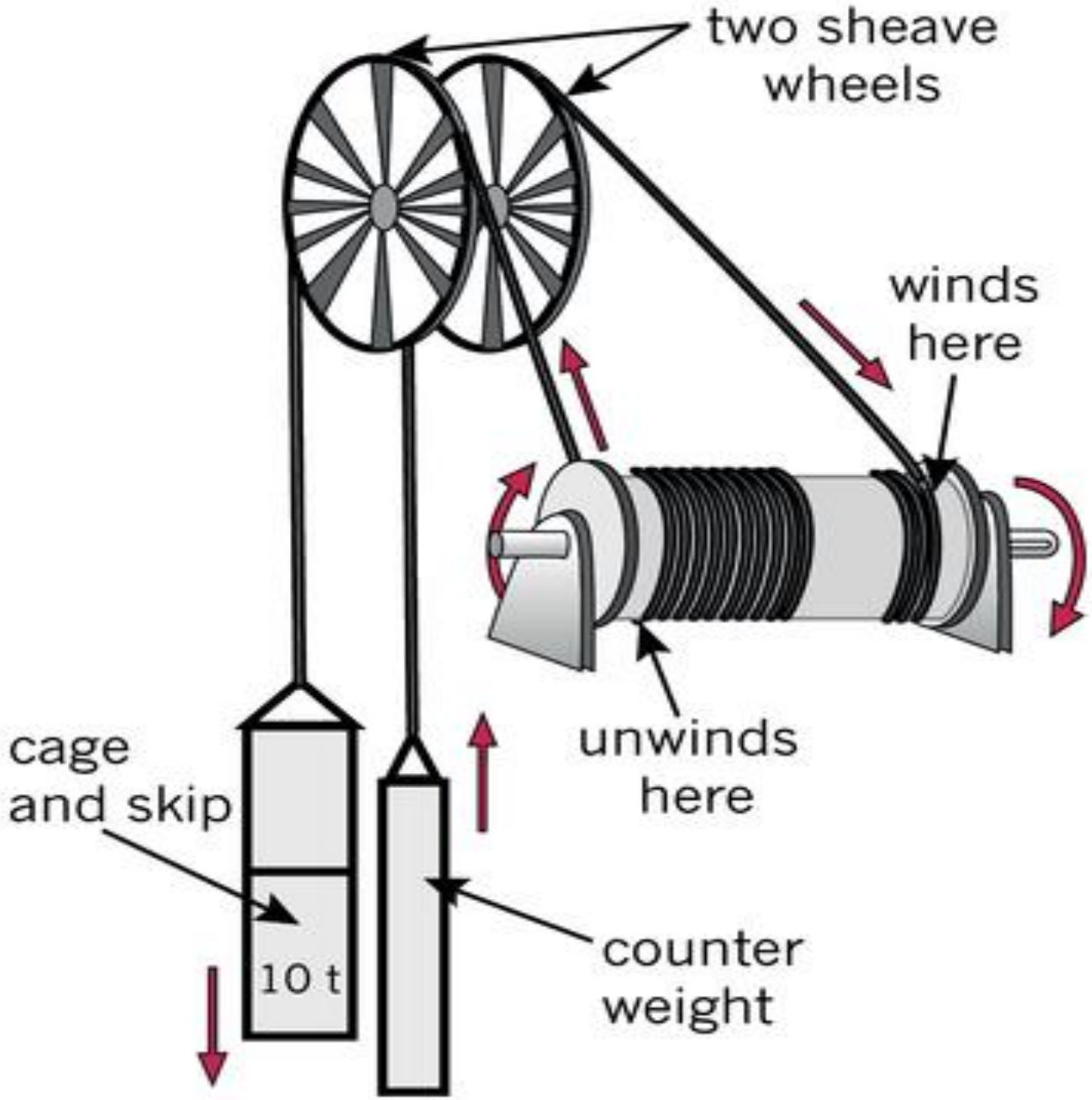
1. Prospecting – Search for ore deposit
2. Exploration – Defining extent and value of ore
3. **Development** - opening up for production
   - Access to the ore body
   - **Shaft** as initial development for underground mining
4. Exploitation – Actual ore recovery
5. Reclamation – mine closure

Mine Shaft

- Shafts play a major role in the general planning of mine development and in the life of an underground mine.
- A hoist together with its associated plant for underground mine is the single most important and expensive element of the mine.
- It is the most sophisticated mine plant.

Shaft sheave wheels

Shaft sheave wheels, drum and cage / skip



Considerations for Mine Shaft Site – shaft location

Mine Layout

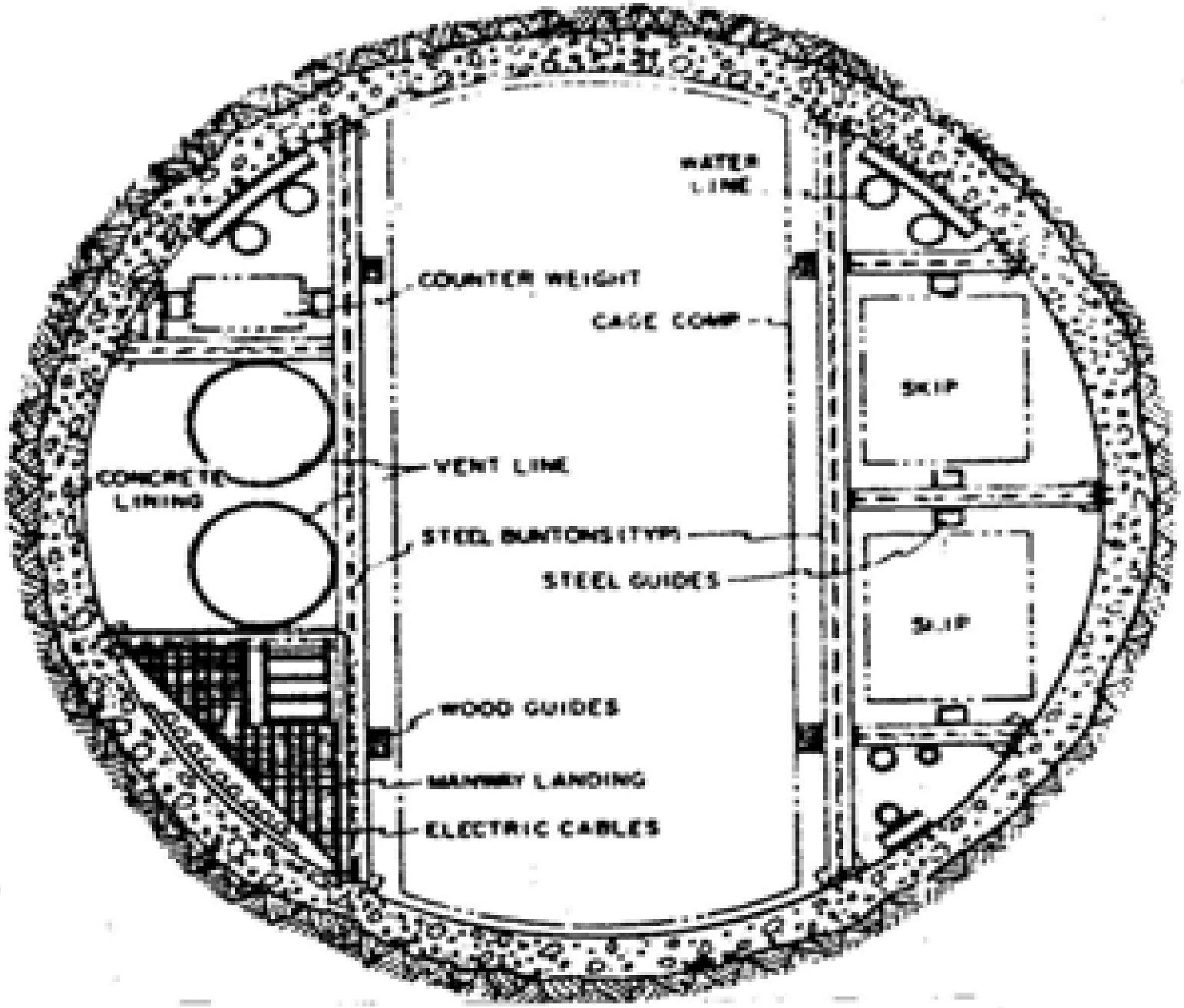
- Road networks
- Offices
- Plants
- Parking sites

Permanent plant – life of a mine

- Competent rock
  - Less artificial support
- Distance to the ore body
- Source of energy
- Maintenance space

A Mine shaft consists of:

- Facilities for materials handling, such as ore and waste rock
- Means of transport for mine workers
- Arrangement for water lines, ventilation, drainage, power supply, and communication
- For safety reasons materials handling compartment is separated from personnel compartment.


WATER LINE
COUNTER WEIGHT
CAGE COMP
SKIP
VENT LINE
CONCRETE LINING
STEEL BUNTONS (TYP)
STEEL GUIDES
SKIP
WOOD GUIDES
MANWAY LANDING
ELECTRIC CABLES

Functions of a mine shaft include:

- To access an ore body
- To transport men and materials to and from underground workings
- For hoisting ore and waste from underground
- To serve as intake and return airways for the mine ventilation

By mining law:

- At least two shafts per mine
  - To provide a second egress
  - Alternative access to and from underground workings
- Cages and skips
  - To be suspended in the shaft by wire ropes
  - To operate in balance
- Ropes connected to the head gear

Shaft design parameters:

- Depth of shaft
- Ore and waste tonnage to be handled
- Shift handling (work force)
- General materials handling
- Mining machinery handling
- Ventilation requirements
- Capital costs
- Operating costs
- Price of the mineral commodity

Classification of Mine Shafts

Mine shafts may be classified as:

- Vertical shaft
- Inclined shaft
- Double staged shaft

- Rectangular Shafts
- Circular Shafts
- Elliptical Shafts

SHAFT SINKING

Shaft mining or shaft sinking refers:

- To the method of excavating the shaft
- Opening from the top down,
  - Where there is initially no access to the bottom.

An important requirement in shaft sinking:

- To provide optimum fragmentation
- Quick removal of muck
  - Congested shaft-face area.

Mine Shaft Sinking

- In shaft sinking, shaft collar is initially excavated
- Shaft collar is the foundation of the shaft
- Shaft collars are normally line with concrete.

There are different methods of shaft sinking.
The two generic methods are:

Conventional and Raise-boring methods

Conventional Method

- In conventional method, a shaft is constructed by drilling holes and filling with explosives.
- Using this method, drilling and blasting can sink around 5m to 7m in one blast.
- The number of holes N required for sinking a shaft of cross section area A in m^2 is estimated by:

  $N = 2.5A + 22$

Conventional Method

Disadvantages of conventional method include:

- Labour intensive,
- Unsafe
  - Explosives
  - Fumes
  - Toxic gases
  - Dust
  - Falling objects
- High running costs

Conventional Method

- Blasting operation is carried out against gravity, and the scatter of the broken rock is confined in the shaft.
- It is common to use generous distribution of explosives throughout the rock using a large number of small diameter (35 – 42 mm) shot-holes.

Mucking

- Mucking is an operation of loading broken rock or cuttings and hoisting up to surface
  - Manually or machine loading
  - Usually in shaft
- Usually mucking requires some skip-hoisting, bucket-hoisting or clam-shell grab equipment

Mucking

Shaft Support systems

There are three major ways of supporting shaft walls:

1. Use of timber support,
2. Use of roof bolts, and
3. Use of wire mesh.

Rock strength classification	Strength range (MPa)	Typical rock types
Very weak	10 – 20	Weathered sedimentary rocks
Weak	20 - 40	Weakly-cemented sedimentary rockd
Medium	40 – 80	Competent sedimentary rock
Strong	80 – 160	Competent igneous rocks
Very strong	160 - 320	Dense fine-grained Quartzite or igneous rock

Revision Questions

1. Describe five (5) functions of a mine shaft

2. In comparison to raise-boring, explain three (3) advantages of conventional shaft sinking

Question 3

It is required to sink a 860m-deep circular shaft from surface to just below the ore body using a conventional method. The operations are being carried on a three-shift per day basis. The rock hardness is about 165MPa. If other auxiliary operations take a day every after 18m advance and 39 blast holes are drilled and blasted per shift:

a) Estimate the cross section area of the shaft

b) Estimate how long it will take to complete sinking the shaft if it takes 2 days per metre to set up a 20m shaft collar

c) Describe the support system suitable for this shaft

d) Explain three advantages of conventional method of shaft sinking.

- In conventional method, a shaft is constructed by drilling blast-holes and blasting
- Using this method, drilling and blasting can sink around 5m to 7m in one blast
- The number of holes N required for sinking a shaft of cross section area A in m^2 is estimated by:

$$N = 2.5A + 22$$

$N = 2.5A + 22$

$39 = 2.5A + 22$

$39 – 22 = 2.5A$

$17 = 2.5A$ therefore: Area of the shaft = $6.8m^2$

860m deep shaft and sinking approx., 6m per shift

For 3 shifts thus sinking 18m per day, it will take 840/18 = 47 days

Drilling and blasting = 47 days (shaft sinking)

Supporting and auxiliary operations = 47 days

Collar installation = (20 x 2) = 40 days, thus:

47 + 47 + 40 = 134 days to complete the shaft sinking