2.2 TYPES OF SOFT GROUND

1.Running ground

2.Soft ground

3.Firm ground

4.Self supporting ground

CHARACTERISTICS OF SOFT GROUND:

1.Material is excavated with tools like picks, shovel, axe etc. No heavy and costly equipment is required.

2.Excavation do not require drilling and blasting.

3.Excavation has to be supported immediately after excavation.

4.Progress of work is slow as more precautions are needed during excavation.

5.If the ground is very unstable, it exert enormous pressure upon timber and strutting on roof, sides and bottom.

FACTOR AFFECTING THE CHOICE OF METHOD

1. Size of tunnel
2. Types of ground
3. Available equipment
4. Method of sequence of excavation
5. The extent of ground support method
6. The method of attacking the heading

DIFFERENT OPERATIONS INVOLVED IN SOFT GROUND TUNNELING

1. Setting up
2. Mining or excavation
3. Ground support or timbering
4. Mucking
5. Lining

METHODS OF TUNNELING IN SOFT GROUND

A. Methods requiring use of timbers

1. Fore-poling method
2. Needle beam method
3. Army method
4. Belgian method

5. English method

6. American method

7. Austrian method

8. German method

9. Italian method

B.Other methods

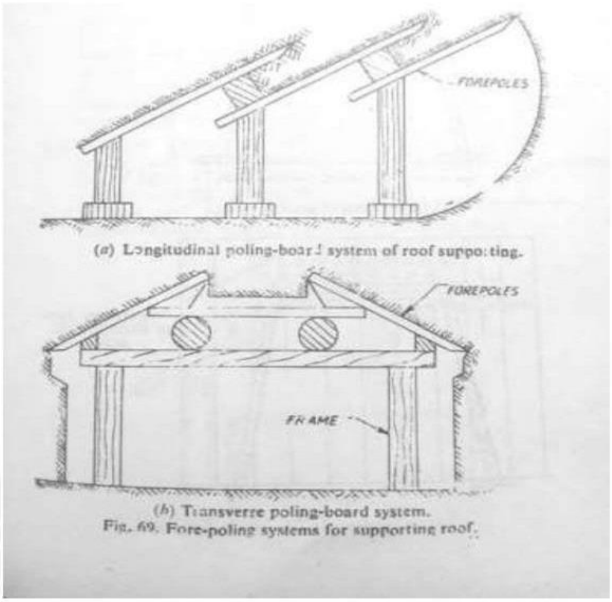
1. Linear plate method

2. Shield method

3. Compressed air method

1. FORE-POLING METHOD;

- The method of fore-poling is commonly adopted for tunneling in running ground.
- It is very old method and it is being gradually replaced by compressed air method.
- This method is slow and hence used for tunnels of small dimensions for laying sewers, gas pipes, etc. at shallow depth.



(a) Longitudinal poling-board system of roof supporting.

(b) Transverse poling-board system.

Fig. 69. Fore-poling systems for supporting roof.

- Ancient method, used for running ground
- Now replace by compressed air tunneling method
- Slow, tedious method but safe.
- Skilled labours and strict provision required.

Sequence of operations for 1.52x1.52 m.

- "A" frame prepared and placed near facing of tunnel.
- Poles are inserted at top which are supported by vertical posts.
- Bent is placed from the sheeting
- Now the excavation can be done under forepoles
- Fore pole consist of plank with wedge ends are entered one at a time
- Driven through half length at 15 cm/m inclination

merits :

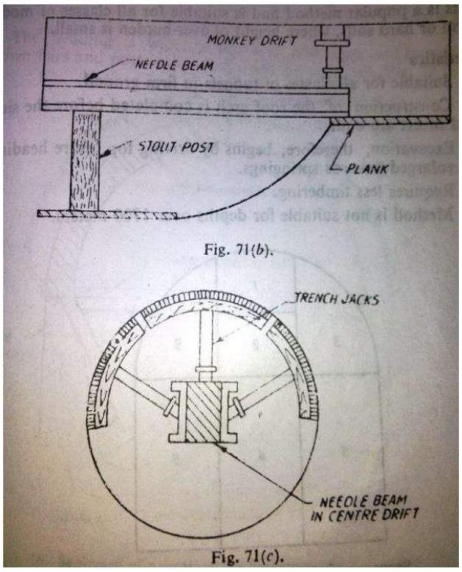
- Used without compressed air
- Used for small dimensions in running ground

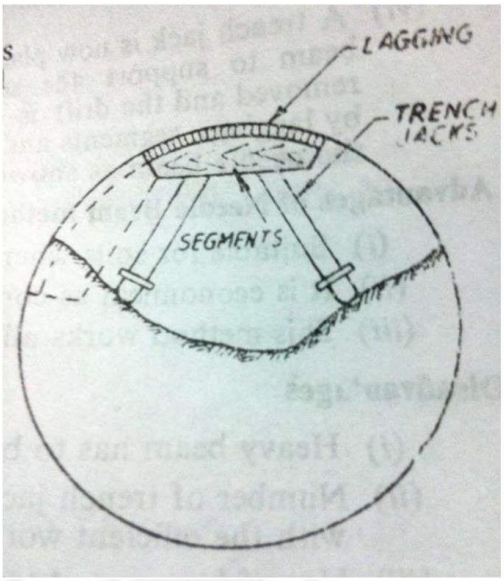
demerits :

- slow process
- used only for small cross section

2. NEEDLE BEAM METHOD;

- This is an economical method of tunneling.
- This method utilized a 5 to 6 m long timber beam known as 'needle beam' which forms the main temporary support during the excavation.
- This method is suitable for soils in which the roof can stand for a few minutes without support and sides walls for an hour or two e.g. firm clay.





Needle beam method

- Suitable for firm ground
- Needle beam consist of a stout timber beam from main temporary support

SEQENCE OF OPERATION :

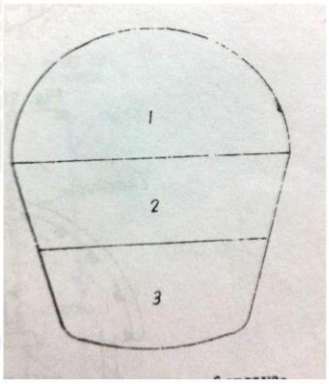
- a drift of about 1m. is driven on working face
- roof of this drift is lagged with sheeting
- apply trench jack on it
- a needle beam of 5 to 6m. is inserted and one end is carried on plank and other on stout post.
- with help of jacks , drift is widened side ways

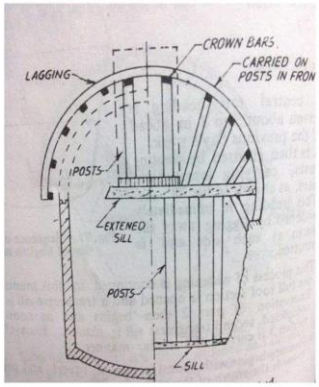
MERITS :
- economical
- works all right on brick lining

DEMERITS :
- heavy beam pushed foreward by hand
- no. of trench jacks required
- difficulties in concrete lining with machine

4. ENGLISH METHOD

- The main characteristics of this method are the excavation if the full section of the tunnel at once using longitudinal strutting and alternate excavation of masonry work and excavation.
- This method involves the use of a lot of timber.





English method

- The main characteristic of this method is excavation of full section of the tunnel at once using longitudinal strutting and alternate of masonry work and excavation

SEQUENCE OF OPERATION :
- Top head is driven up to 5 m.
- It is supported on crown bars
- Then widening of the heading is then done by digging away the earth at each side.
- Then started excavation of part -2 and put the sill
- Part -3 in same manor and started masonry

Merits

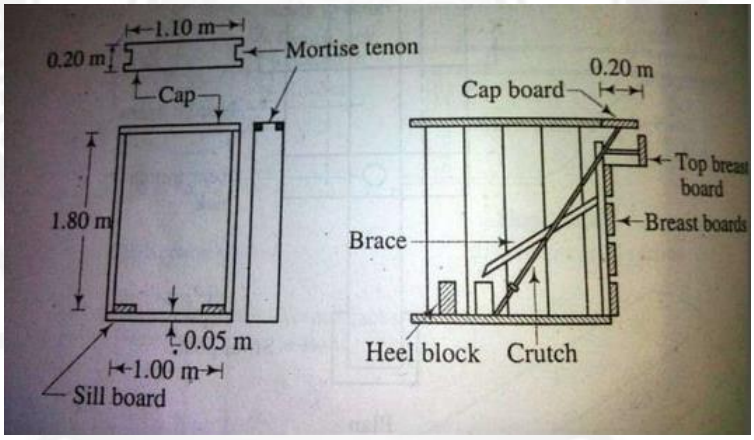
- simple method of hauling are possible
- masonary lining is built , so making the construction strong and homogeneous.

DEMERITES :

- use of lots of timber
- process are slower due to alternate of excavation & masonary

5. ARMY METHOD OR CASE METHOD

- This method was devised by the united states army for construction small tunnels at fairly shallow depths.
- This method was mainly used for laying underground sewers.



- It is derived by USA army for constructing small tunnels at shallow depth.

SEQUENCE OF OPERATION :

- A common gallery of wood 1.1x1.8x0.05 mtr. Of wood is used.
- A top braced is removed and ground is excavated for a short distance.
- The box is moved ahead and set next cap.
- After that remove the breast one by one and excavate .

MERITS :

- Simple,economic
- Outskilled labour can driven

DEMERITS :

- Only for short tunnel

6.AMERICAN METHOD

- This method is mainly used for railway or highway tunnels.

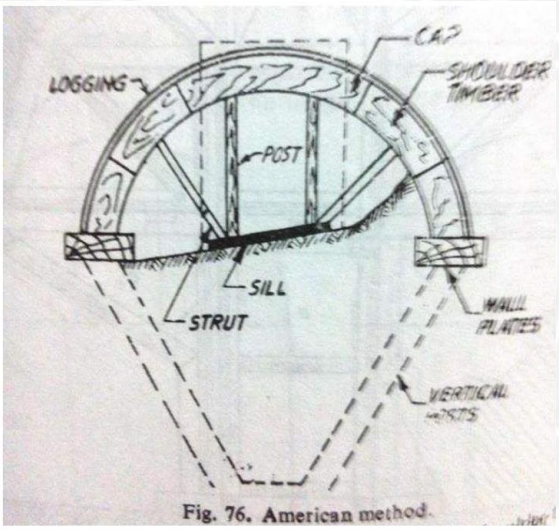


Fig. 76. American method.

Sequence of operations:

1. A top drift is driven and supported by laggings, cap timber and two posts.

2. Sides of the drift are now widened and supported on shoulder timber and struts.

3. Wall plates of 5 m length are introduced at the springing supported the arch set composed of the segment.

4. The wall plates are then under pinned by introducing props or vertical posts at interval.

5. Sides and benching are cleared and tunnel lining is put.

•

7.BELGIAN METHOD

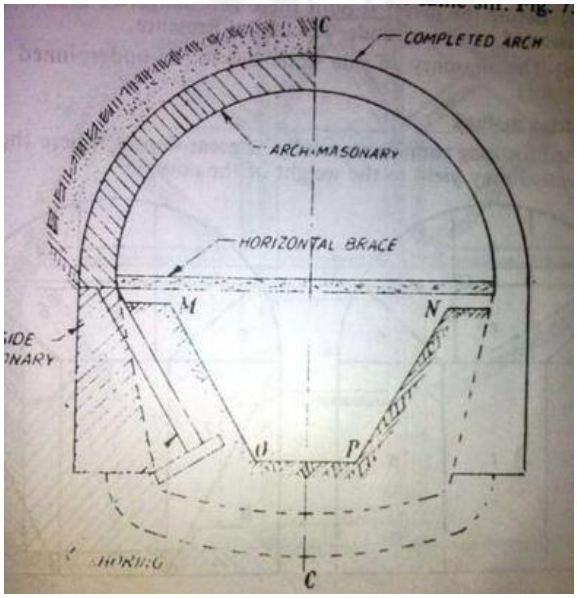
This is a popular method and is suitable for all classes of moderately firm or hard soils, where height of over-burden is small.

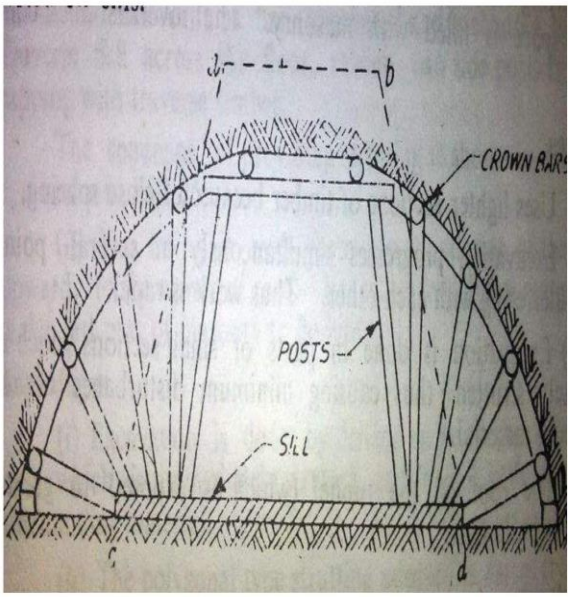
Belgian method

- It is used for moderately firm or hard soils.

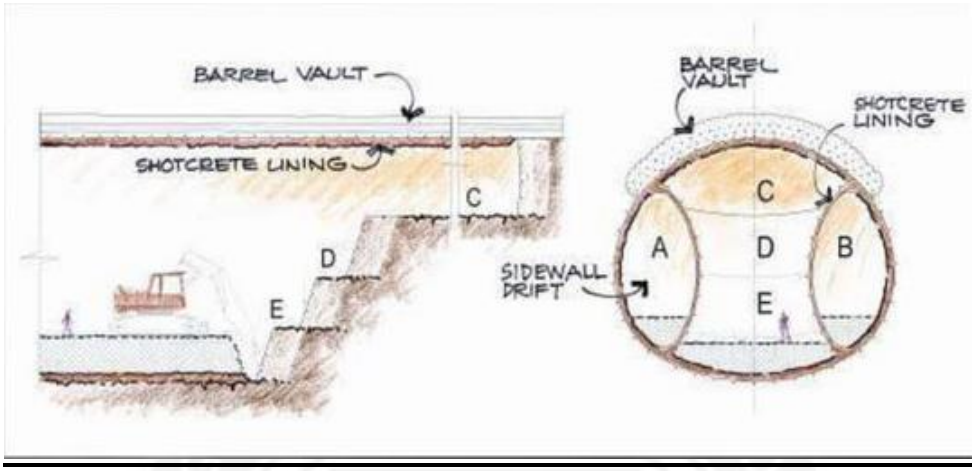
SEQUENCE OF OPERATION :

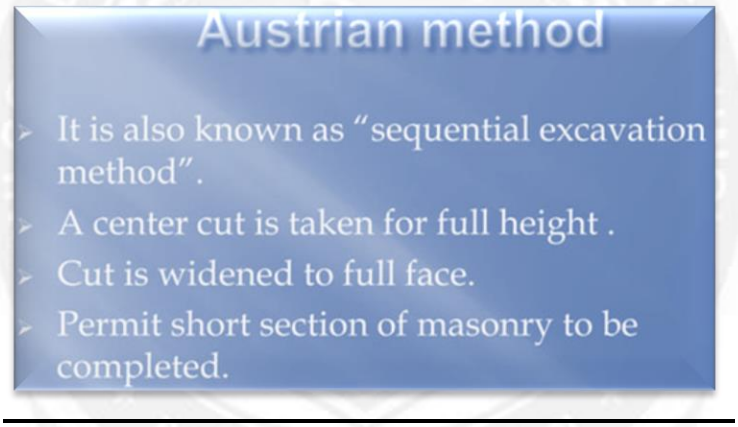
- A top heading abcd for the full rise of the arch is driven & supported.
- Heading is widened sideways , and supported by additional crown bars on sill.
- Lining the arch
- Inserted the shore at side and excavate the mnop.
- Shoring is removed and space is filled with masonary.





8.Austrian Method



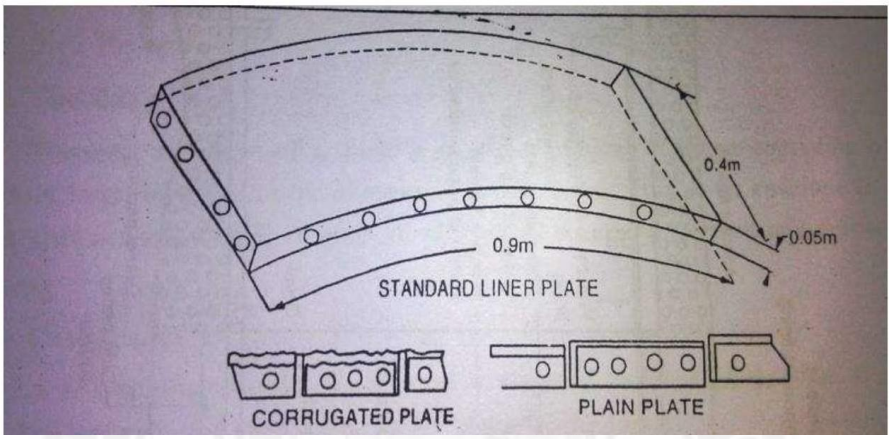


B.OTHER METHODS

1.LINER PLATE METHOD

- Standard sized pressed steel plates, plain or corrugated are used to support the soil, during excavation of short lengths.
- The standard size of a plate is 0.90 m x 0.40 m with 0.05 m flange on all four sides.
- The plates are made with flanges of angle shape on all four sides as shown in fig.
- The plates are bolted to each other through holes in the flanges.
- The bolts are coarse threaded and quick acting.

- Ribs are used for strengthening and stiffening the liner plates in case the diameter of tunnel is more than 3 m.
- I-beam or T-beam are used as stiffeners to the web.



Two types of linear plate methods are

1. Liner plates without stiffeners
2. Liner plates with stiffeners

A. LINER PLATES WITH STIFFENERS

Sequence of operation

1. When ribs are used between liner plates, it is necessary to complete the assembly of each ring, before starting the next.

2. The new plate is bolted to old rib and cantilevered ahead.

3. The new rib is then set and bolted to the edges of plates, nuts and bolts are connecting the rib, must be on forward side of rib as they are removed for bolting up the next ring of liner plates.

LINEAR PLATE WITH STIFFNERES :

- For strenthen the plate "I" or "T" section rib is used as stiffners.

MERITES :

- Lighter, economical
- Erected with unskilled labour
- Fire proof
- Require less number of joints

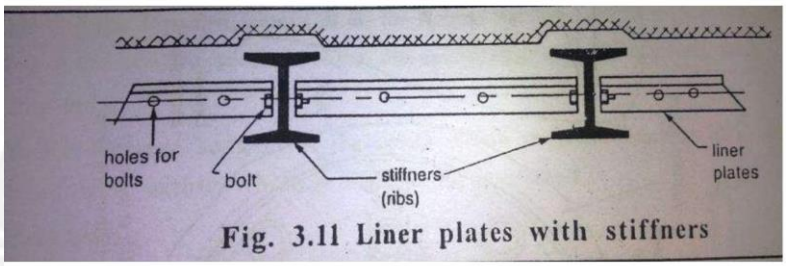


Fig. 3.11 Liner plates with stiffners

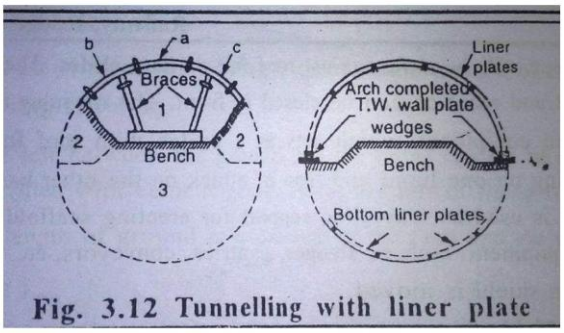


Fig. 3.12 Tunnelling with liner plate

B. LINER PLATES WITHOUT STIFFENERS

Sequence of operation

1. A hole of about 0.4 m in depth is cut out at the crown and a liner plate 'a' is set.

2. Excavation is then widened towards sides and liner plates marked 'b' and 'c' are set. Trench braces or jacks are used if soils pressure are high.

3. Excavation is the carried sideways to the springing line.

4. Now, two wooden wall plates of size about 20 cm x 5 cm and of sufficient length are placed on each side of the bench, wall plate is fixed through spikes.

5. The trench braces or jacks are then removed leaving the liner plates arch to support the roof.

6. The bench is then cleared and the wall plates are under pinned to introduced the bottom liner plates.

2. SHIELD METHOD

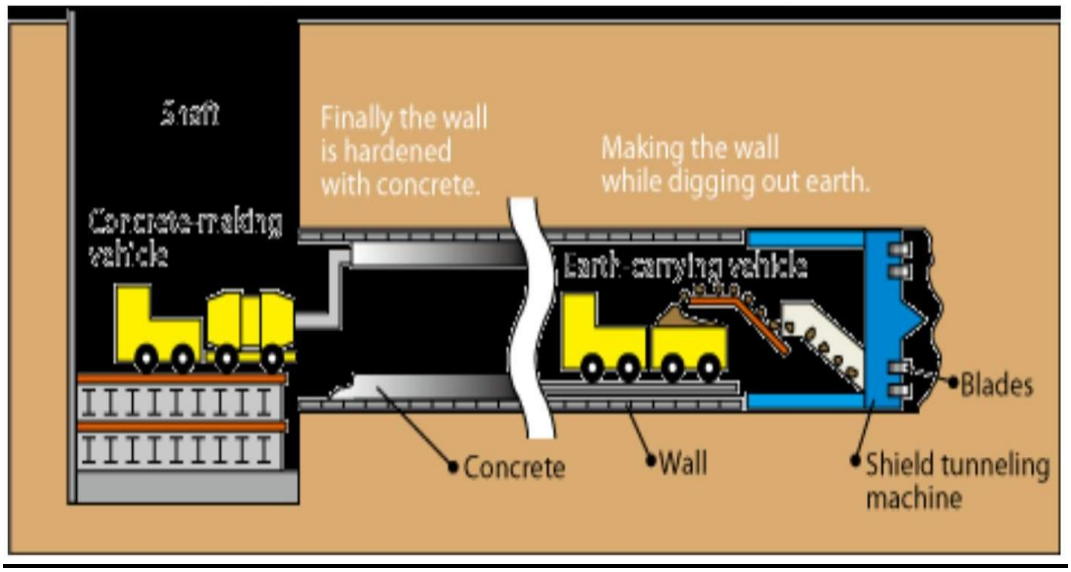
- It is used for driving a tunnel through water bearing strata.
- It is an equipment which acts as a bridge with roof for workers.
- It open at one end or both end.
- It consist sledges , conveyors etc.

LENGTH OF SHEILD :

1. storage required
2. problemes of changing direction

•COMPONENTES OF SHIELD :

•1.The skin
•2.Cutting edge
•3.Propelling jack
•4.The hood
•5.The tail
•6. Port holes



- Resistance to pressure caused by surrounding soil : circular is best

- Permission for rotation of shield about its own axis : circular is preferable

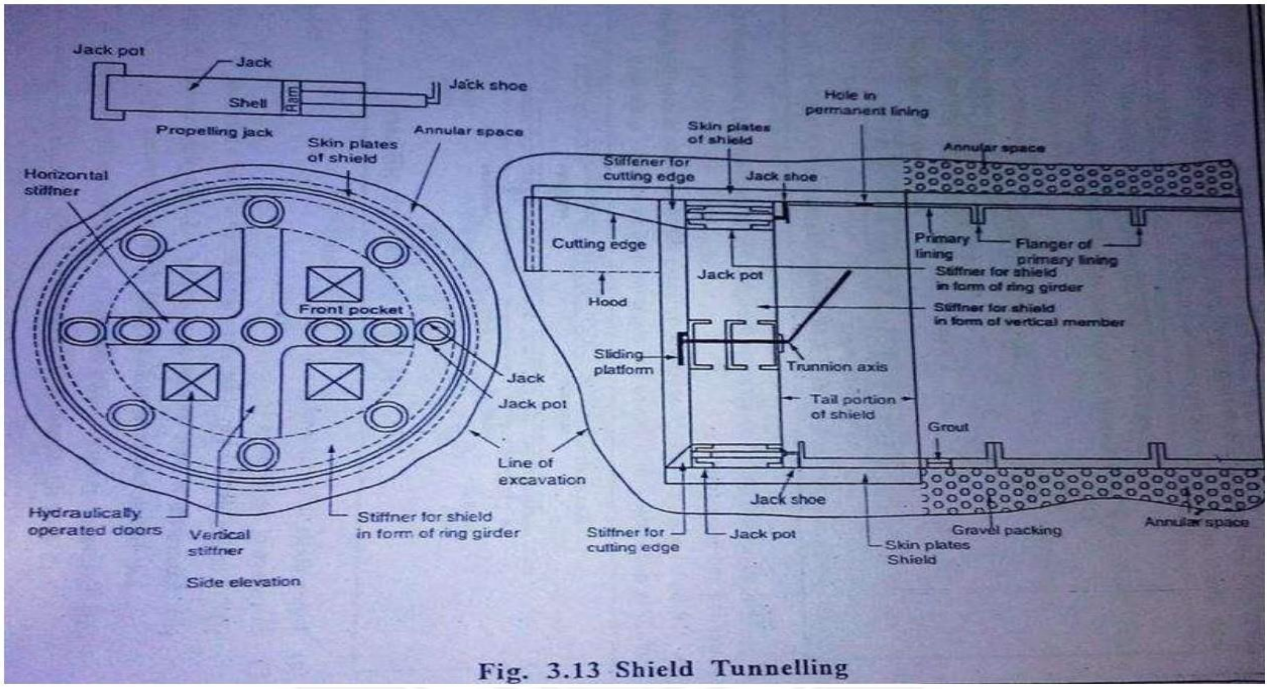


Fig. 3.13 Shield Tunnelling

SEQUENCE OF OPERATION :

- The ground is excavated ahead of the sheild of .45 to .75 meter.
- The shield is jacked forward.

PRIMARY LINING :

- It is the name given to the heavy cast iron lining used in conjuction with the shield.

SECONDARY LINING :

- 5 to 7 cm. concrete is placed over the flange of iron.

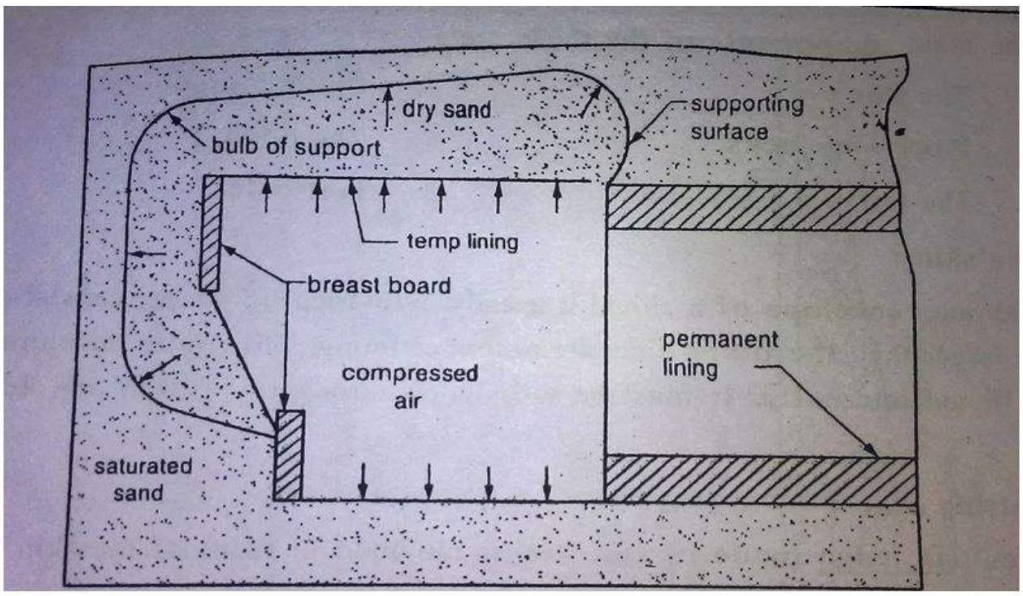
MERITS :

•Full dimension available
•Speedy
•Moving with constant support to the advanced tunnel.

3. COMPRESSED AIR METHOD

The essential principle of this method is the used of compressed air and is very well suited for soft or water bearing ground.

The method consist in forcing air under suitable pressure into an enclosed space like a tunnel heading, to force back percolating water or water mixed with soils and thus stabilize the area of excavation.



EQUIPMENTES FOR COMPRESSED AIR TUNNELING :

- air lock & accessories
- bulk head to fix air lock
- blow line
- air compressor
- gas trapes
- **DURATION OF WORK IN COMPRESSED AIR FOR LABOURES :**
- p = 12.5 pa ;8 hr(break 0.5 hr)
- p= 14 to 21 pa; 4 hr (break 2hr)