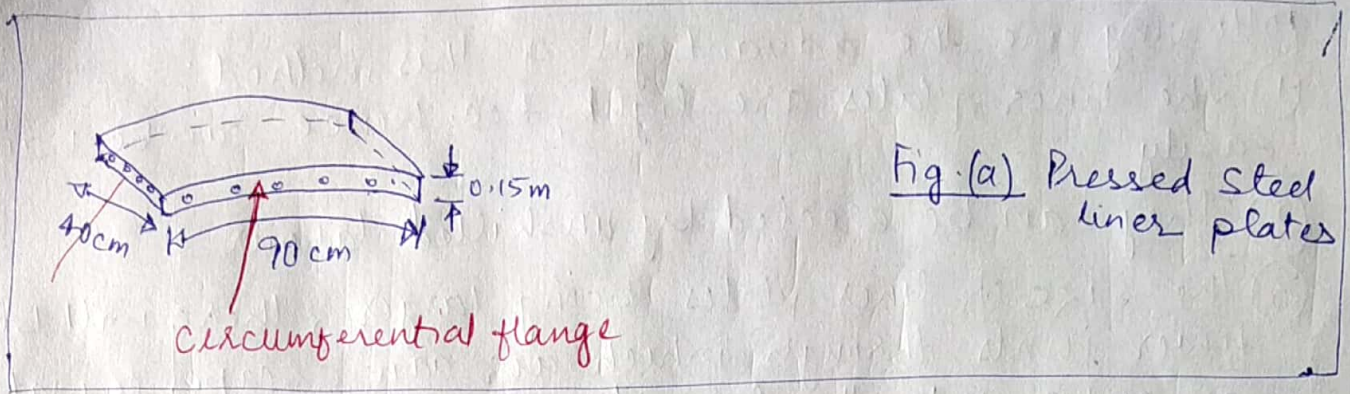


3) Liner Plates Method

This method of tunnelling in soft grounds is of recent origin. In this method, timbering is replaced by standard sized pressed steel plates.

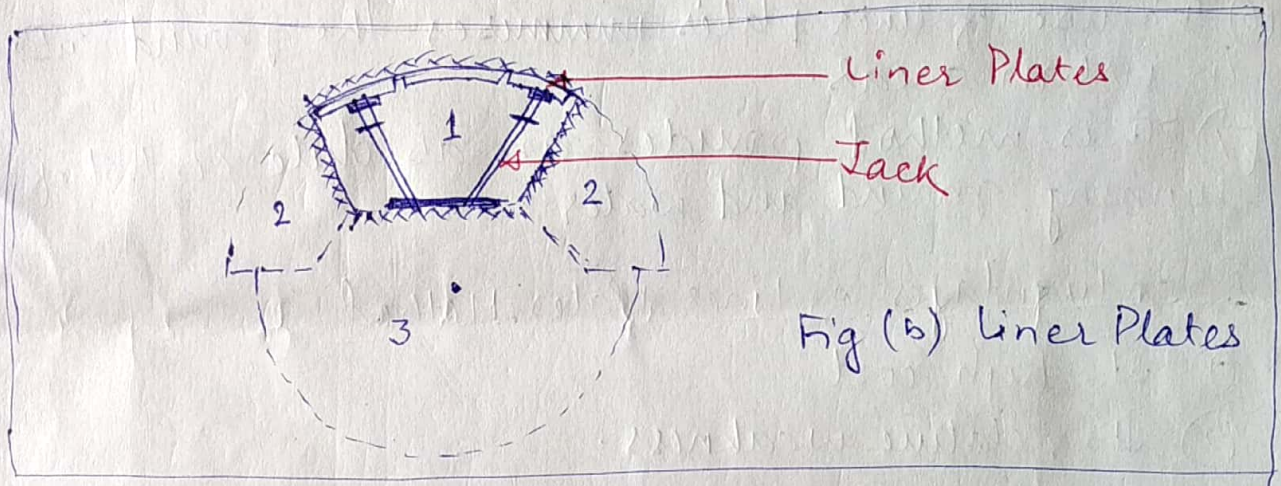
Light steel plates for tunnelling in soft grounds for the first time were used in 1879 in Haskin's tunnel, but the use of pressed steel plate is of very recent past.

- The pressed steel plate is 40cm wide and 90cm long with 5cm flange on all the four sides.
- The skin is corrugated to stiffen the plate. Plate of different weights and lengths are available.
- To make up the required circumference plates of $\frac{3}{4}$, $\frac{1}{2}$ or $\frac{1}{4}$ lengths are available.
- In order to use the full length sheets, sheets of length equal to π are also available.
- The thickness of these plates vary from 3.25 to 6.5mm
- For tunnel diameter of about 2.0m, 3.25mm thick plate is sufficient.
- For 2.5 to 3.5m diameter tunnels, 6.5mm thick sheet is found quite suitable.
- For tunnels larger than 3.5m in diameter, use of ~~3.25~~ 3.25_{mm} liner plates with I-beam ribs at 40cm centres is quite satisfactory.
- The depth of I-beam may be chosen as 2.5cm per metre diameter of the tunnel.
- Figure (a) shows a pressed steel liner plate.



Erection of Plates and Ribs

- The standard method of erecting ~~linear~~ liner plates without ribs is shown in fig. (b)



- In this method first of all a 40cm deep hole is cut and the roof is trimmed carefully and the crown plate is set.
- The excavation is then widened out and the adjacent plates set on each side as shown.
- If there is any ground pressure on plates, ~~are~~ the plates are supported with the help of jacks. Usually this method is repeated till at least three rings of plates have been started. The rings are set breaking the joints

Advantages of Liner Plates Method

following are the advantages of this method:—

- ① The liner plates are light, ~~too~~ hence can be handled easily.
- ② They can be erected by unskilled labour
- ③ The size of liner plates being larger, there will be fewer joints through which air can escape or water can enter into the tunnel.
- ④ They are fire proof, hence they can be safely used while working under compressed air.
- ⑤ They have a great deal of excavation and concrete work
- ⑥ The use of liner plates minimises the ground subsidence in urban areas.
- ⑦ This method provides an absolute control of running ground and water.

Disadvantages of Liner Plates Method

- ① Its high cost
- ② Its relative weakness.

④ Shield Method ✓

- A shield is a cylindrical structure made of steel. Though the shield was first ~~pat~~ patented in 1818 in U.K. but the present type of shield was patented in 1865 by Mr Barlow in U.K. ~~Shields~~
- Shields are used to drive circular tunnels in soft grounds
- The circular shape is chosen due to following reasons:-
 - ① Circular shape is most ideal to resist the semi-fluid pressures in soft ground.
 - ② It provides greatest cross-sectional area with the minimum of perimeter
 - ③ The rotation of shields in circular shape is easy without affecting primary lining, which is erected in the tail. Nowadays tunnelling in soft grounds or soils is done with the help of shields.

Essential Parts of Shield

following are the essential parts of shields:-

- ① Skin or outer Shield :- Usually it is made up from several curved plates joined together by welding or riveting. To eliminate radial joints, shields are made of single length sheets from front to rear position. Small shields can be made out ~~from~~ of a single plate with welded butt seams.
- ② Tail :- It is that part of the shield which extends upto the rear end within which primary lining is erected. The length of the tail in general should be such that it may cover $\frac{1}{2}$ rings of the primary lining. As the primary lining is not braced or supported from inside, it must be designed to resist all external pressure without distortion.

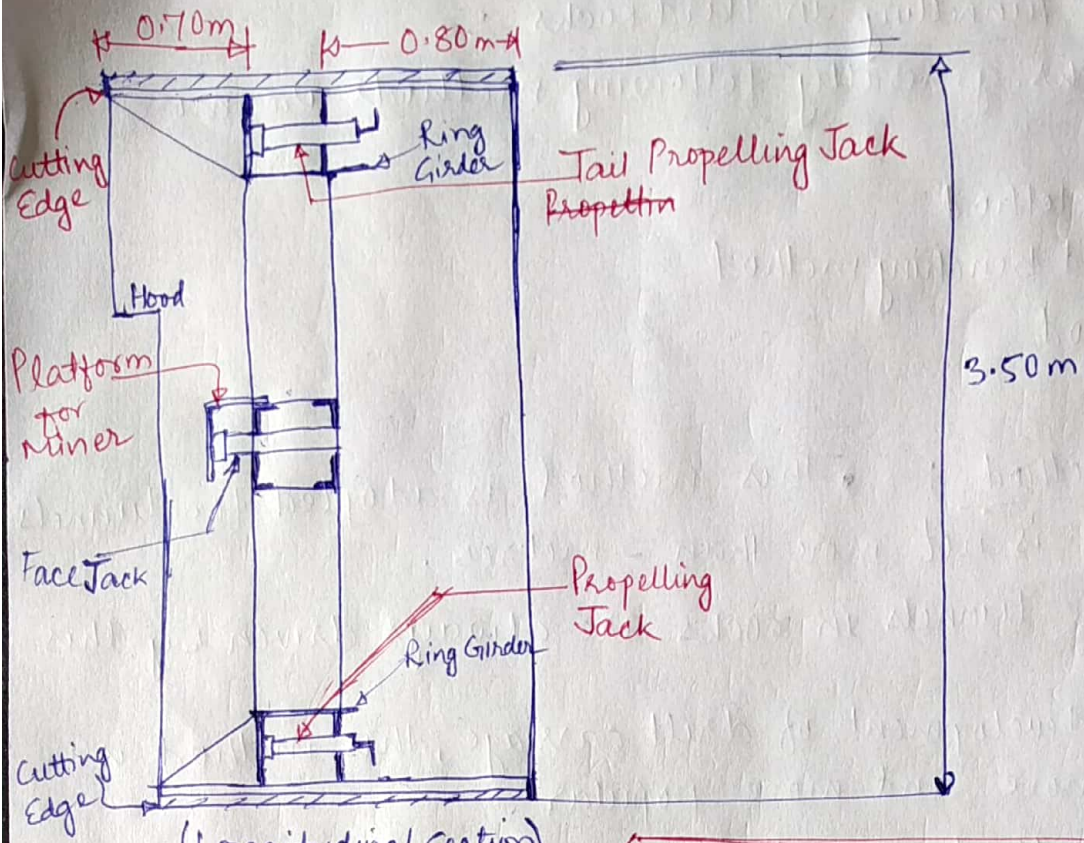
③ Cutting Edge :- On small shield, the cutting edge is usually the skin plate itself, protected against abrasion by ~~co~~ coating hard surfacing material such as tungsten carbide. On larger shields, segments of cast steel are used as cutting edge. They are bolted to the front end of the shield. They can be replaced easily if damaged. This is their main advantage.

④ Hood :- It is the forward extension of the top section of the cutting edge, usually extending through the top 150 degrees of the circumference.

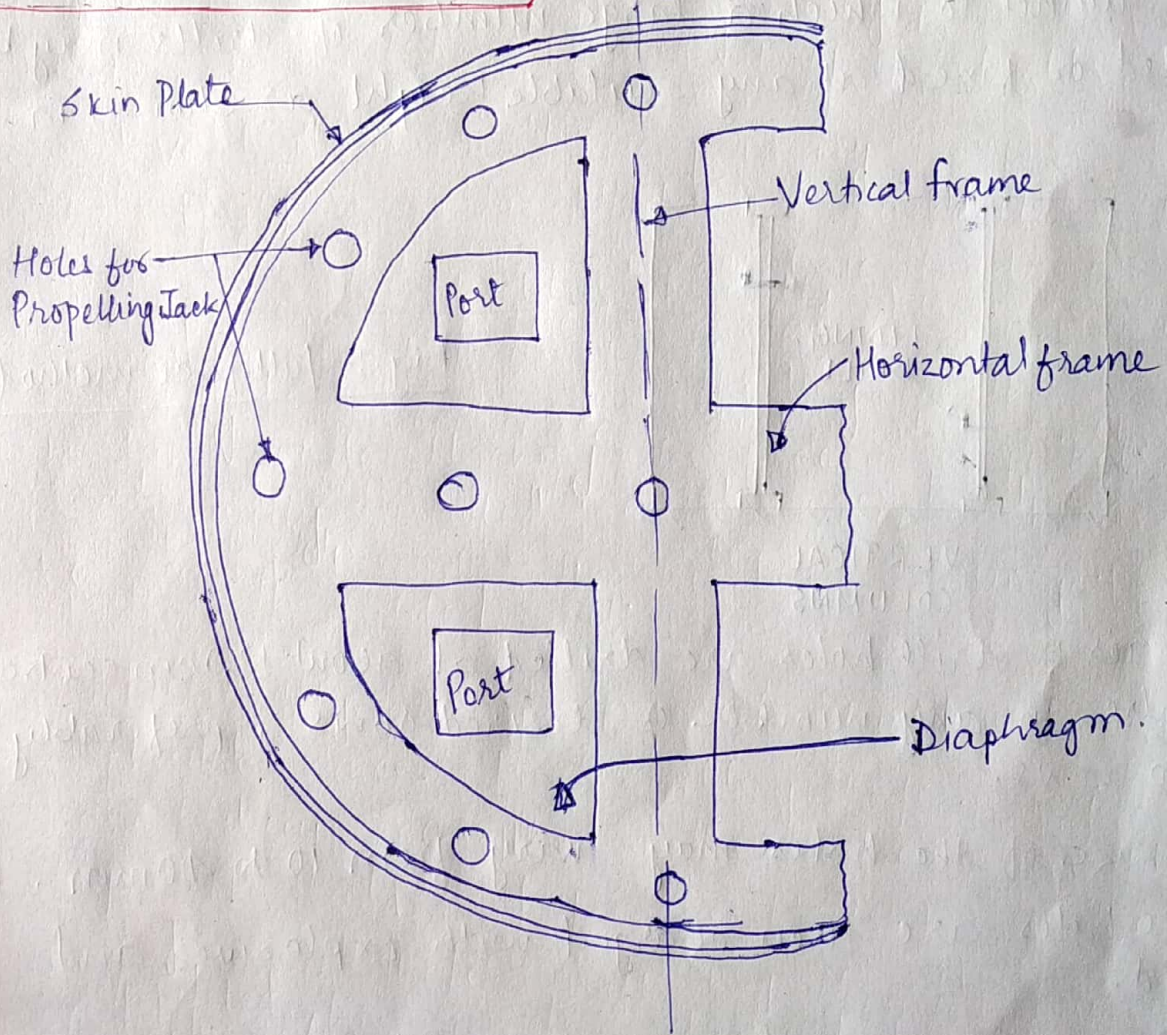
⑤ Inner Structure :- Generally two or three girders are used to stiffen the skin plate against distortion.

⑥ Pockets :- The front of large shields is divided into 1.25m wide and 1.5m high pockets by horizontal and vertical frames. The primary purposes of frames or diaphragms is to stiffen the shield structure against distortion due to eccentric loads on the cutting edge, but the horizontal frames also provide convenient platform or scaffolding for the workman to stand while attacking the face. In pockets, platforms are usually mounted on hydraulic jacks and can be extended under the hood as working platforms.

- Shields mostly have been used for tunnel work in U.S.A., U.K., and France for tunnelling under rivers and tubes, railways etc. The tunnels can be taken through clay, silt, sand and similar soils.
- The progress of these tunnels has been found varying from 0.6m to 3.7m a day depending on the type of soil. The diameter of these tunnels may vary from 3.0 to 9.0m



• (Longitudinal section) of Shield Tunnel



• (Cross-section) of Shield Tunnel.