

3.3 TUNNEL BORING MACHINE

Tunnel boring machine (TBM) as more recent developments in the tunnel driving technique. The function of TBM is to loosen the earth or break the rock continuously in the entire section of the tunnel, into cuttings and convey to the rear of the machine, where it can be loaded into muck cars or dumpers or on to conveyor belts for the transportation to the ultimate disposal site.

Working principle and construction features of TBM

These machines perform the boring operation through rotation of the front head against the rock face. The machine has circular cutter head in the front provided with fixed cutters of desired shape. The cutter head while rotating is pressed against the rock to cut or pulverize it. The cuttings while falling down is collected in the buckets provided around the cutter head periphery. These buckets discharge the muck into a hopper to feed it into the belt conveyor leading to the rear of the machine. This conveyor then discharges the muck either into the mine car or to another belt conveyor leading to the portal of the tunnel. The muck or cuttings can also be disposed off by using the slurry pipelines after mixing the fine muck into water to form slurry.

For driving through full-face on full-face TBMs number of cutter heads is mounted on a drum. The drum when rotates in one direction, the individually driven cutter heads having projected Tungsten carbide tipped tools can be rotated in another direction and the drum advances into the tunnel face, by providing a thrust with the help of hydraulic systems. The tips of the tools when worn out can be easily replaced. The tips are kept cooled by spraying a mixture of water and

compressed air into the cutting area. This also suppress the dust formed during cutting.

Advantages of tunnel boring machines

- ✓ There is very less danger of fall outs in machine bored tunnels, since adjacent or surrounding rocks are undistributed as no blasting is done.
- ✓ Mucking is also safe and convenient, since muck is conveyed from the face to the rear of the machine and is loaded automatically by means to the rear of the machine and is loaded automatically by means of belt conveyors.
- ✓ Higher speed of excavation.
- ✓ Reduction in the tunnel supports requirement.
- ✓ Less manpower requirement.

Various types of tunneling technique

Tunneling techniques are

1. Drilling
2. Drilling jumbo
3. Loading and firing

Drill jumbo

Drill jumbos used in tunnels are also known as tunnel jumbos. A drill jumbo is a portable carriage having one or more carriage having one or more working platforms equipped with columns, bars or booms to support and guide the drills, enabling the drills to perform drilling operation at any desired pattern. These platforms have arrangement for the supporting the compressed air pipes, water pipes. The booms are operated by hydraulic fluid or air and support the drifters, and are equipped with control enabling the operator to spot a drill in any desired position conforming to the drilling pattern. The platforms are constructed as per the size of tunnel and can be raised or lowered so as to allow mockers or hauling equipment to pass under the jumbo several drill can be operated from each platform for speedy excavation

The jumbos either on rails on pneumatic tyres depending upon the type of work. The jumbo can be equipped with electricity feeding cables, pneumatic concrete placers etc. Mobile jumbos of modern design with four wheels drive and centrally articulated steering speeds production and reduce tunneling costs

Loading and firing

Drilling pattern when followed produces most economical and efficient breakage of rock for a given tunnel, and is determined by conducting tests using different patterns. Explosive selected for working in tunnels should have low fumes characteristics. Ammonium nitrate explosives are therefore preferred over dynamics due to less toxic fumes

Drilling

For driving a tunnel number of holes are drilled as per drilling pattern in size and depth as decided depending upon the size of the tunnel and its formation Drifters are generally used for drilling in the tunnels where water is used to remove the cuttings from the holes instead of compressed air to reduced the amount of dust in the air. Holes are drilled slightly deeper than the advance per round to taken care of loss in depth during blasting. Depth advanced due to drilling and blasting operation is called as one round.

Types of well point systems

1. Pumping from open sumps
2. Pumping from well points

Well point systems are installed in two ways:

- a) Line system
- b) Ring system

Types of 3. Pumping from bored wells
piles

- (a) Driven piles – Timber, recast concrete, Prestressed concrete , steel H-section, Box and tube
- (b) Driven and cast-in place piles
- (c) Bored piles
- (d) Composite piles

Use of H-piles

H-Piles are used in construction of bridges where they can be driven through existing construction in small spaces they are used useful for driving close to existing structures since they cause little displacement of soil. It can withstand large lateral forces. They require less space for shipping and storing than wood, pipe or precast concrete

They not require special slings or special care in handling.

DEEP EXCAVATIONS

Problems normally developed during deep excavations

- ☐ To prevent the collapsing of sides of the trenches
- ☐ To prevent water oozing or coming out from the sides and bottom of the trenches

The remedial measures to avoid the problems deep excavation

- ☐ Providing shoring for the trenches
- ☐ Dewatering of the trenches

Line system

This system is employed when excavation area is long. The header is laid out along the sides of the excavation, and the pumping is continuously in progress in one length as further points are jetted ahead of the pumped down section and pulled up from the completed and back filled lengths and repeated till entire length is completed. For narrow excavation, like trenches, header is laid only on one side, while for wide excavations, the header are required to be placed on both sides of the area.

Ring system

When excavation is done in area of appreciable width, line system is inadequate. The ring system is used in such condition and the header main surrounds the excavations completely. This system is used for rectangular excavations such as for piers or basements.

