# UNIT-4 Tunnel Engineering

## QUESTION 1 Define lining of tunnel. (Sum-22, Marks-2)

ANS: A layer of timber, iron, masonry or concrete provided on the inside of a tunnel is known as lining of tunnel.

## QUESTION 2. Sketch various types of tunnel cross-sections. State under what conditions each is adopted. (Win-23, Marks-4 ) (Sum-22, Marks-4 )

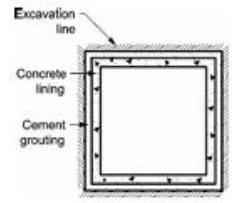



Fig.1: Rectangular shaped tunnel.

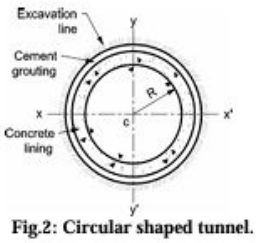



Fig.2: Circular shaped tunnel.

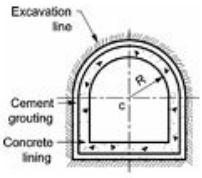



Fig.3: Segmental shaped tunnel.

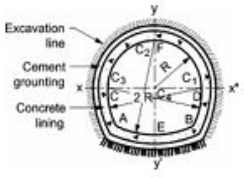



Fig.4: Horse-shoe shaped tunnel.

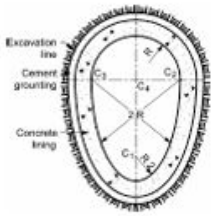



Fig.5:Egg-shaped tunnel

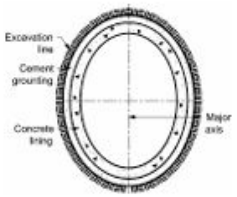



Fig.6:Elliptical shaped tunnel

| Sr. No. | Types of tunnels according to shape | Suitability |
|---|---|---|
| 1. | **Rectangular or box type shape** | These tunnels are suitable for pedestrian purpose. |
| 2. | **Circular shape** | These tunnels are commonly use for carrying water under pressure. |
| 3. | **Segmental shape** | Segmental tunnels are suitable as traffic tunnels These tunnels are commonly used in subways or as navigation tunnels. |
| 4. | **Horse shoe shape** | These tunnels are suitable in soft rock. |
| 5. | **Egg type shape** | Suitable for flow of sewage in dry and wet seasons. |
| 6. | **Elliptical shape** | These tunnels are suitable for carrying water. |

## QUESTION3. Explain Tunnel Surveying and 3 steps involved in Tunnel surveying. (Sum-22, Marks-4)

ANS: **Tunnel surveying:** The process of setting out the alignment of the tunnel on the ground and then transferring the same to inside of the tunnel through shafts is called tunnel surveying.

**i) Locating centre line of the tunnel on ground :**

1. After fixing the route for the tunnel, its centre line (alignment) is accurately set out on the hills or ground.

2. When the length of tunnel is small, the centre line can be located by means of theodolite. 3. When the tunnel is long, and to be constructed under high mountains, the centre line is set out by triangulation preferably with the help of a micrometer transit theodolite.

**ii) Constructing the shaft over the centre line :**

1. After locating centre line, shafts are constructed at regular interval.

**iii) Transferring the alignment to inside of the tunnel**:

1. After constructing the shafts, the alignment of the tunnel is to be transferred down the shafts

2. Two plumb bobs are suspended inside the shaft by lowering both plumb bobs to the bottom of the shaft, two points are marked.

3. The line joining the points represents the centre line of the tunnel marked on the ground.

4. This line is further extended into the tunnel, as work advances, by a theodolite placed in the shafts.

## QUESTION 4. List the factors affecting size of tunnel (Win-19, Marks-2)

ANS: i) Volume and type of traffic.

ii) The size of clear opening required.

iii) The thickness and allowance of lining.

iv) Drainage facilities required.

## QUESTION 5. State the necessity of providing tunnel shaft. (Win-19, Marks-4 )

ANS 1) To provide opening for removal of muck.

2) To expedite the construction work of the tunnel by starting excavation at several points at the same time.

3) To provide passageway for pumping out the water from the tunnel.

4) To provide natural ventilation during construction of the Tunnel.

## QUESTION 6. State the purpose of providing tunnel lining and state the factors affecting type of lining. (Sum-23, Marks-2 ) (Win-23, Marks-4 ) (Win-19, Marks-4 )

ANS: **Purpose of tunnel lining:**

1. To provide the correct desired shape to the tunnel.

2. To support the loosened rock pieces during blasting.

3. To increase the structural strength of soft places in the tunnel.

4. To improve the appearance of tunnel.

5. To prevent percolation of water inside the tunnel.

6. To reduce the maintenance cost of tunnel.

7. To house electrical fitting.

8. To withstand soil pressure when driven in soft rocks.

**Factors affecting type of lining:**

1. Type and nature of rocks 2. Purpose for which the tunnel is constructed

3. Funds available 4. Aesthetic consideration.

## QUESTION 7. Describe in brief with neat sketch construction of tunnel with needle beam method (Sum-24, Marks-4 ) (Sum-23, Marks-4 ) (Win-19, Marks-4 )

ANS: In this method stout timber beam known as needle beam is used which forms the main temporary support during the excavation.

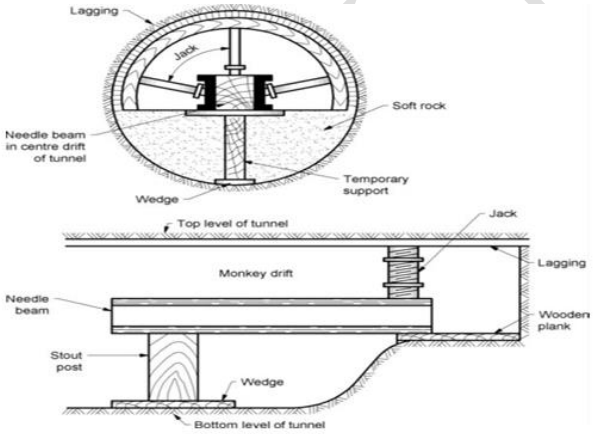
**Construction steps:**

(a) First of all a small drift of about 1 × 1 m is prepared on the working face of tunnel.

(b) The roof of this drift is then supported on lagging provided on wooden segments which are carried on the trench jacks as shown in the fig.

(c) The needle beam is placed horizontally, whose front end rests on drift and the rear end is supported on vertical stout post.

(d) After excavation, the lining is provided to the tunnel section and mucking is done.




## QUESTION 8. Sate the purpose of tunnel maintenance and discuss the measures to be taken for proper maintenance. (Win-19, Marks-4 )

Ans: **Purpose of tunnel maintenance:**

1) For safe movement of traffic 2) To avoid accidents during rainy days

3) To increase life of tunnel 4) To use tunnel economically

**Measure to be taken for proper maintenance**:

1) The dimensions of tunnel section should confirm with its original dimensions

2) Lining of tunnel should be examined

3) All weep holes are required to clean time to time

4) Side drains should be cleaned time to time

5) Ventilation shaft to be checked

6) Observe the landslides in nearby areas

7) Observe the leak. If it is there, then take preventive measures.

8) Check the conditions of lining.

## QUESTION 9. Classify tunnels based on its purpose.

(Sum-24, Marks-2 ) (Sum-19, Marks-2 )

ANS: I. Railway tunnel II. Highway tunnel III. Navigation tunnel

IV. Subway tunnel V. Pedestrian tunnel VI. Water supply tunnel

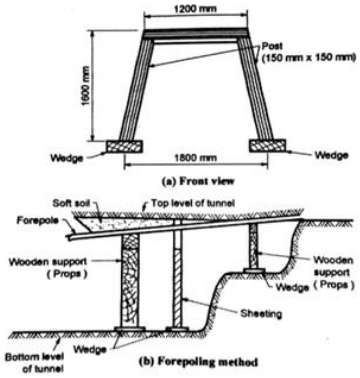
VII. Sewer tunnel VIII. Hydro – electric power tunnel

IX. Tunnels for industrial use. X. Tunnels for intake and conveying public utilities.

## QUESTION 10. Describe fore-poling method of tunnelling in soft rock.

(Sum-19, Marks-4)

ANS: It is an ancient method of tunneling, but now it has been replace by compressed air method. This method needs large quantity of timber for supporting the ground. This method used for the construction of small dimensions tunnels required for laying sewers, gas, pipes etc. it is slow and tedious. In this method, a frame in the form of letter 'A' is prepared and placed near the face of the tunnel covered with suitable planks as shown in fig. The poles are then inserted at the top and continued to a depth up to which they can be easily taken up. These poles are supported by verticals posts. Now excavation can be done under the forepoles.The excavations are also done on sides and are supported by suitable timbering. In this way the full section of the tunnel is excavated.




## QUESTION 11. Explain the tunnel ventilation using mechanical method.

(Sum-24, Marks-4 ) (Win-19, Marks-4 )

Ans: **Mechanical method :** Mechanical ventilation is done by blowing fresh air into a tunnel or by exhausting the foul air or dust from the tunnel by any system listed below :

**(1) Blowing process :** • In this method of mechanical ventilation, fresh air is forced by on e or two blowers through the ducts, provided in the tunnel.

• By this method, positive supply of fresh air at the working place can be obtained.

• But the disadvantage lies in that the foul air, smoke and dust slowly move out, fogging the atmosphere inside the tunnel, especially in long tunnels.

• This method is also known as propulsion method.

**(2) Exhausting process:**

• In this method of mechanical ventilation, air is sucked by one or two exhaust fans installed near the tunnel heading.

• This creates vacuum due to which fresh air enters inside the tunnel.

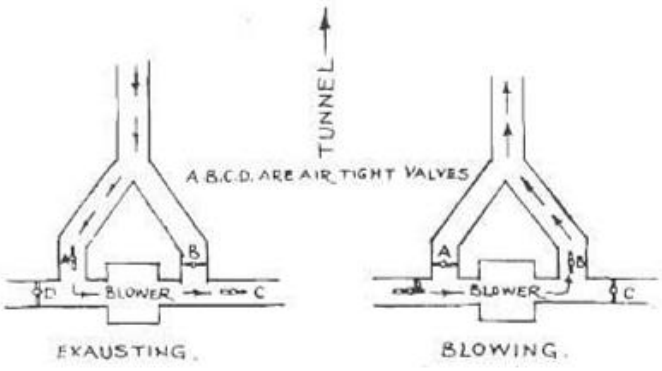
• This method has the special advantage of quick removal of dust and smoke from the working face.

• This method is also known as vacuum method.

**(3) Combination of blowing and exhausting process :**

• In this method, blower and exhaust fans are provided for forcing fresh air in the tunnel and sucking foul air from the tunnel.

• The blower and exhaust fans are installed in suitably spaced inlet and outlet shafts connected to the tunnel.




## QUESTION 12. State the necessity of providing tunnel. (Win-23, Marks-2 )

Ans: The necessity of providing tunnel:

1. To provide passage for railway track. 2. To provide passage for roads.

3. To provide access to mines. 4. To lay conduits for water etc.

5. They connect the terminal stations by the shortest route and thus results in less transportation cost.

6. They help on avoiding holding-up of traffic for long periods due to traffic congestion and provide rapid transportation.

7. They help in avoiding acquisition of costly and valuable land property for transportation projects.

## QUESTION 13. Explain with sketch drift method of tunnel excavation in hard rock. (Win-23, Marks-4 )

Ans: • It consists in driving small size heading. Centrally at top or bottom of the face, which is later enlarged by widening and benching.

• The main operations involved in this method are as follows:

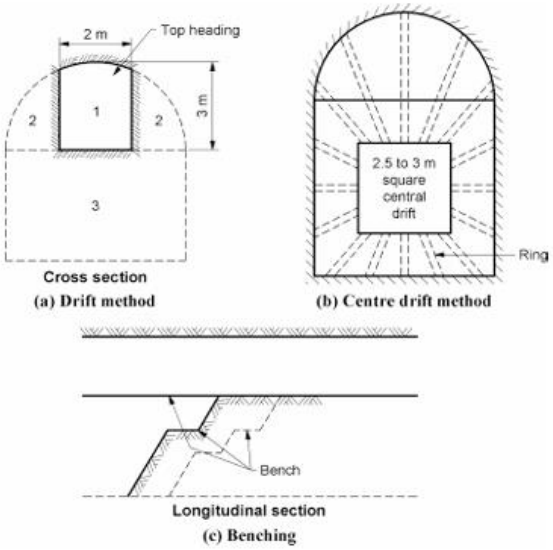
(i) Boring or blasting a top centre heading of drift. (ii) Widening and enlarging.

(iii) Benching in stages.

• In this method, a drift of 2.5 m × 3 m (minimum) size or sufficient to accommodate the tunnelling machinery, labour and mucking equipment etc.

• After making the central drift, holes are drilled for widening the face of the proposed tunnel.

• These drilled holes are then loaded with suitable explosive and fired step by step as shown in Fig. and Fig shows types of drift.




## QUESTION 14. Describe in brief transferring of centre line in inside the tunnel with neat sketch. (Win-22, Marks-4 )

Ans: First of all shaft is constructed. After construction of shafts, the center line of tunnel is to be transferred down the shafts. For this purpose, generally two small pillars are constructed on opposite edges of the shaft along the center line of the tunnel. On the top of pillars, the points corresponding to the centre line are correctly marked and a wire is then stretched between them. After this two plumb bob are suspended by piano wire inside the shaft as shown in figure

above. Two points are then marked by lowering plumb bob to the bottom of the shaft. The line joining the two points represents the center line of the tunnel marked on the ground. These lines are further extended into the tunnel heading as the work advances, by a theodolite placed in the shafts. Points along the centre line are marked by a peg provided with plumb bobs, fixed to the roof of the tunnel as shown in figure below.

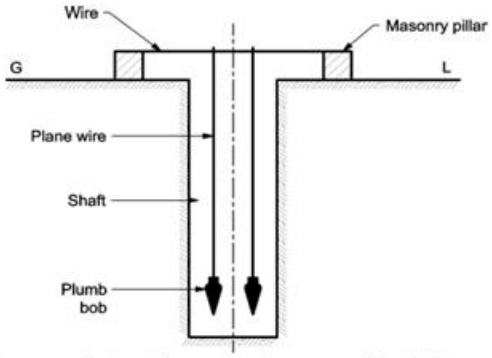



**Fig. :Transferring Alignment at the Bottom of the Shaft**

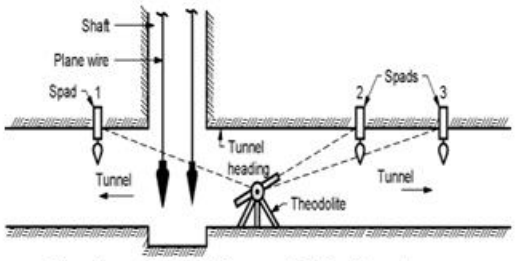



**Fig. :Transferring Alignment Inside Tunnel**

## QUESTION 15. Define Tunnel. (Win-22, Marks-2 )

Ans: The underground passages which are constructed without disturbing the ground surface are known as tunnels.

## QUESTION 16 Enlist the types of explosives used in tunnelling (Win-19, Marks-2 )

ANS: Following are the types of explosives mainly used for tunneling.

1. Disruptive explosive 2. Power explosive 3. Liquid air explosive

## QUESTION 17. Draw a neat sketch of tunnel for a national highway showing its components and dimensions. (Win-19, Marks-4 )

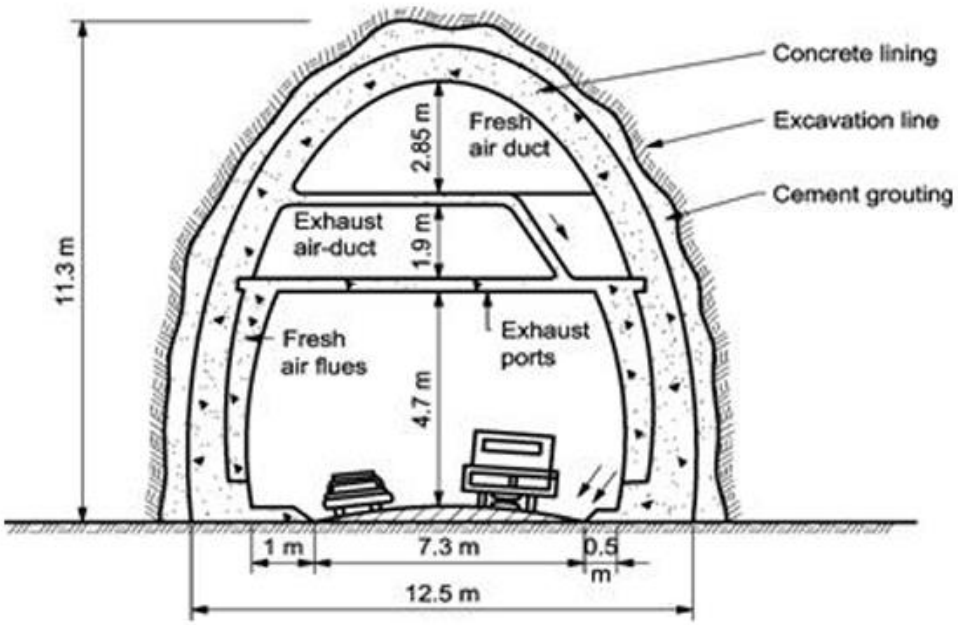



**Fig. :Cross Section of Tunnel for a National Highway**

## QUESTION 18. What is tunnel investigation? State its necessity in detail.

Ans: **Tunnel Investigations :** The field and laboratory investigations of the area to obtain the necessary subsurface and general data for the safe and economical design and layout of the tunnel are known as tunnel investigation.

**Necessity for tunnel investigation** :

1. To locate underground presence of water, fault planes etc, so as to overcome problems which are likely to occur during tunneling.

2. To know the nature and type of strata through which the tunnel is to be drive so as to decide a suitable method of tunneling.

3. Tunnel should pass through the hard rock, as the chances of accidents are much less as compared to soft rock.

4. The alignment should be such that the excavation work is minimum.

5. The alignment should not be near water channel.

6. The portal of the tunnel should be near the dumping yard so that the muck may be disposed of in lesser time.

7. The alignment should be as straight as possible.

8. Minimum possible grade should be provided in tunnel. After considering the above two points its shape and size may be decided, depending upon the nature of ground and purpose for which it is to be used.

## QUESTION 19. State precautions to be taken while construction of tunnels.

Ans: Depending on the purpose of tunnel, shape should be decided.

1. Cross - sectional dimensions of the tunnel should be decided to achieve economy in its construction.

2. In order to make proper use of labour and equipment, sequence of operation must be well planned previously.

3. Labour should be well organized to maintain continuous progress of the tunnelling operations.

4. The use of outdated and unsuitable tools must be avoided.

5. Each and every operation must be completed in scheduled time as far as possible.

6. Loading and hauling of muck should be carried out efficiently.

7. In order to achieve economy, the sequence and type of lining should be determined in advance.

8. Selection of multipurpose and uniform type of equipment should be made, according to the size and shape of the tunnel.

9. Pattern of blasting the material in different locations should be decided for maintaining speed of driving and safety.

## QUESTION 20. Draw cross section of tunnel for a double line Broad gauge railway track.

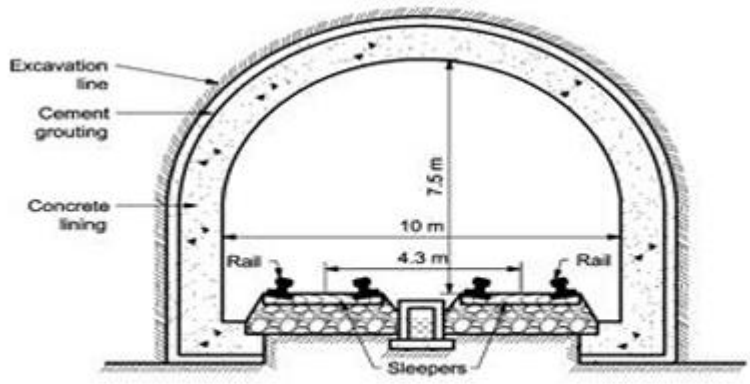



Fig. Cross-section of tunnel for a double line broad gauge railway track.