



SUMMER – 19 EXAMINATION

Subject Name: Transportation Engg.(TEN)

Model Answer

Subject Code:

17418

**Important Instructions to examiners:**

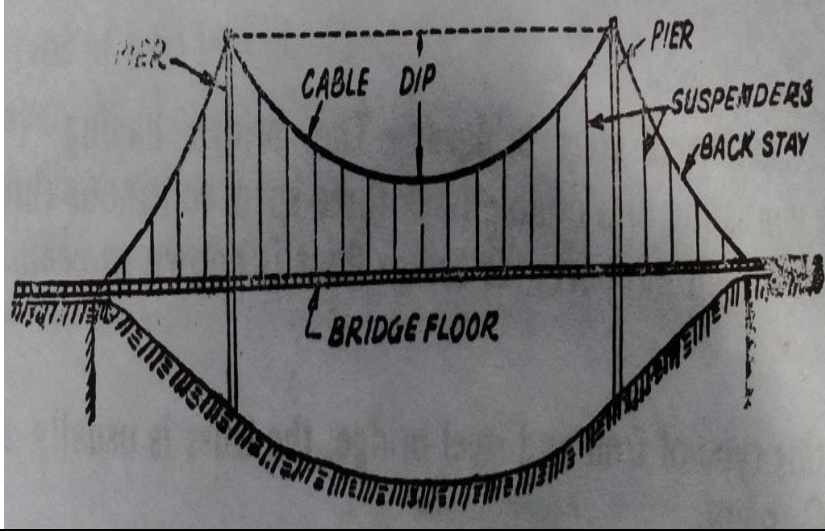
- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	(a) (i) Ans.	<b>Attempt any <u>SIX</u> of the following :</b> <b>Enlist modes of transportation system.</b> The different modes of transportation system are as follows: (1) Roadways (2) Railways (3) Airways (4) Waterways	(12 M) (2 M)  2 M (1/2 Mark each)
	(ii) Ans.	<b>State the necessity of cross drainage works for roads.</b> <b>Necessity :</b> The stability of road pavements can only be maintained if their surface and foundation bed remain in dry condition. The entrance of water in the subgrade or any other layers of the road pavement, even for short intervals, is undesirable and dangerous because it is considered as one of the major causes of the road failure. Hence it is necessary to provide proper cross drainage works for roads.	(2 M)  2 M
	(iii) Ans.	<b>Enlist two advantages of railways.</b> Following are the advantages of railways: (1) Railways provide a comfortable and safe means of communication within the reach of a common man. (2) Transport of bulk of letters, parcels and heavy goods like raw materials, coal, ores etc. from the mines and manufacturing concerns for long distance is cheap and convenient only by Railways. (3) Railway transport requires less amount of power due to less tractive resistance of steel wheel and steel rails. (4) Railways provide employment to millions of people. (6) Railway forms the chief source of revenue to a country without any taxation.	(2 M)  2 M any TWO (1 M each)



		(7) During famines and calamities, railway help in providing medical aid and other help to those affected by it. (8) Railways play an important role in the industrialization of country.	
	(iv) Ans.	<b>Define 'Coning of wheel'.</b> <b>Coning of wheel :-</b> The art of providing an outward slope of 1 in 20 (1:20) to the treads of wheels of rolling stock is known as coning of wheels.	(2 M)  2 M
	(v) Ans.	<b>State different types of railway stations.</b> The following are the different types of railway stations. (1) Wayside stations (2) Junction stations (3) Terminal stations	(2 M)  2 M
	(vi) Ans.	<b>Define – HFL and free board.</b> (1) <b>HFL</b> – The level of the highest flood ever recorded or the calculated level for the highest possible flood discharge in a stream or river is called <i>Highest Flood Level (HFL)</i> . (2) <b>free board</b> – The difference between the highest flood level after allowing the afflux, if any, and the lowest point on the under side of the bridge superstructure is called <i>free board</i> .	(2 M)  1 M  1 M
	(vii) Ans.	<b>Define – Pier and abutment.</b> (1) <b>Pier</b> – The intermediate supports for the superstructure of a multi-span bridge are known as pier. (2) <b>Abutment</b> – The end supports of a bridge superstructure are known as abutments.	(2 M)  1 M  1 M
	(viii) Ans.	<b>State any two purposes of providing tunnels.</b> The tunnels are provided for following purposes: (1) For transportation of men, material and goods. (2) For conduction of water to generate power. (3) For carrying oil, sewage, gas etc. (4) For providing access to mines.	(2 M)  2 M Any two 1 Mark each
1	(b) (i) Ans.	<b>Attempt any TWO of the following:</b> <b>State the basic requirements of good alignment for railway track.</b> The following are the basic requirements of good alignment for railway track between two terminal stations: 1. The alignment should be straight and short so as to provide economy in the cost of construction, maintenance and transportation. 2. The alignment should be easy for construction, maintenance and traffic operations, when there is minimum gradient and flat curves. 3. The alignment should be safe for traffic operations. 4. The alignment should be economical when it have less cutting and filling and it should have less number of cross drainage works such as bridges and culverts etc. 5. The alignment should be of maximum utility. 6. The alignment should have a good natural aspect when it will pass through regions of natural beauty and scenery.	(8 M) (4 M)  Any Four 1 Mark each  4 M
	(ii) Ans.	<b>State the points to be considered in connection with bridge approaches.</b> The points to be considered in connection with bridges approaches are as follows: (1) In case of high level bridges and culverts, the approaches are constructed in embankment, while for submersible bridges or causeways, they are provided in cutting. (2) According to I.R.C. recommendations, the approaches should be straight for a	(4 M)  2 M



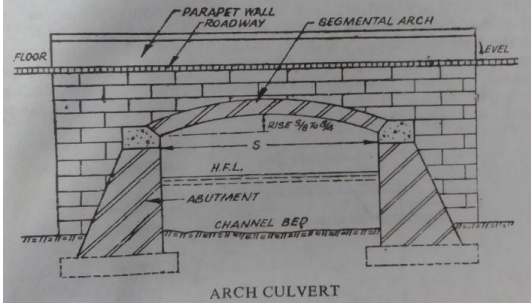
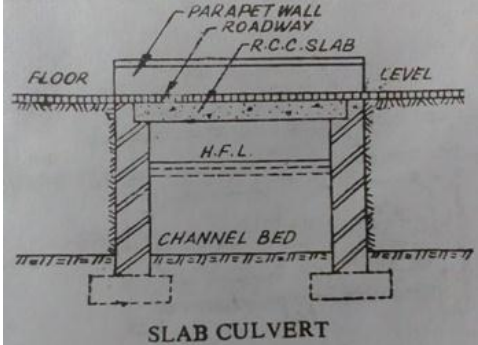
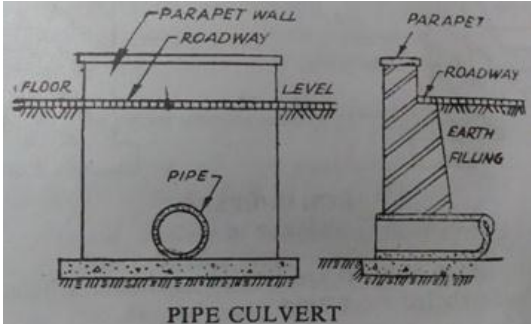
		<p>minimum length of 15 m. on either side of the bridge, where horizontal curve have to be provided on the approaches beyond the straight portion on either side with necessary radius of curvature and superelevation.</p>	<p>2 M</p>
	<p>(iii) Ans.</p>	<p><b>Draw a neat labeled sketch of suspension bridge.</b> The labeled sketch of suspension bridge:</p> 	<p>(4 M)</p> <p>2 M for diagram 2 M for labeling</p>
<p>2</p>	<p>(a) Ans.</p>	<p><b>Attempt any <u>FOUR</u> of the following:</b> <b>Define 'Alignment'. State the factors governing rail alignment.</b> <u>Alignment</u>: Marking the position of center line on the ground and giving direction to the railway track is known as alignment of the railway track. <b>* Factors governing the rail alignment</b> : Following are the factors governing road alignment: (1) <b>Obligatory points</b>: The alignment should pass through obligatory points such as intermediate important towns, group of villages, and places of commercial, social, political and military importance. (2) <b>Traffic</b>: - The alignment should suit the traffic growth and its impact should be studied carefully and the alignment should pass through thickly populated area. (3) <b>Geometric Designs</b>: To get the maximum benefits of a railway alignment the geometric design of the following elements should be made very carefully.     (a) <u>Gradient</u>: The alignment should have gradient not steeper than permissible limit, in order to avoid excessive fall or rise, the alignment is to be changed.     (b) <u>Curves</u>: The alignment should have flat curves. Sharp curves should be avoided by changing the alignment. (4) <b>Topography of Areas</b>:     (a) <u>Valley Alignment</u>: If the two terminal points lie in the same valley then the straight shortest alignment may be chosen without any difficulty and a uniform rate of gradient may be adopted.     (b) <u>Cross Country Alignment</u>: In such type of alignments, the water sheds of two or more streams of different sizes have to be crossed and it is not possible to give a uniform grade to the track. It is due to the fact that rail levels are so high that there are no appreciable summits or sags between the ridges. Thus, the routes in cross country have sags and summit in succession.     (c) <u>Mountainous Alignment</u>: The main object in railway alignment is to keep the track as straight as level as possible. In mountainous region this objective is achieved by</p>	<p>(16 M)</p> <p>(4 M)</p> <p>1 M</p> <p>3 M (any Three 1 mark each)</p>

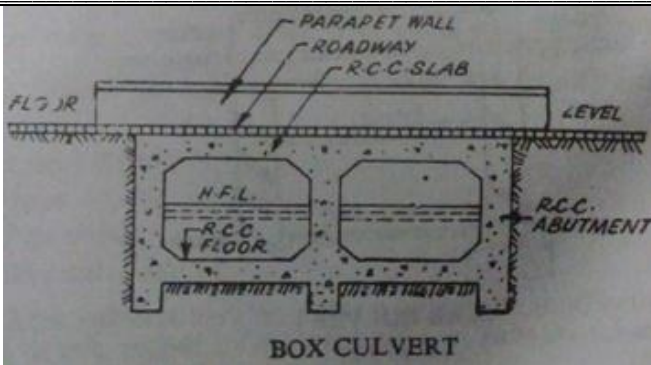


		increasing the length of the track keeping the gradient up to the limit of ruling gradient.	
2	(b) Ans.	<b>State the necessity of railway track maintenance.</b> The railway track maintenance is necessary due to the following reasons: (1) The newly laid track settles down due to heavy axle loads and high speed of trains. The elastic structure of the railway track thus gets disturbed in alignment, gauge, and surface level of rails. (2) The track components are subjected to deteriorating effects of weathering agencies like rain, sun and storm and hence the wear and tear of the track components is likely to take place. (3) The track components are subjected to many other deteriorating effects due to heavy wheel loads, curvature and speed of trains, particularly on curves, points and crossings, bridge approaches and at level crossings. (4) To maintain the track components and other facilities in good condition so as to provide safe and smooth movement of trains at specified speed.	(4 M)  4 M (1 Mark each)
2	(c) Ans.	<b>State the duties of permanent way inspector and gang mate.</b> Following are the duties of <u>permanent way inspector</u> : (1) He is the in-charge of his section and is personally responsible for maintaining the railway track in good working condition. (2) He is to inspect his section at least 2 to 3 times a week and to detect the defect on the track. (3) He is to check the gauge, super elevation, depth of ballast and to adopt measures to remove the defects. (4) He is to make arrangement to correct creep in his section. (5) He is to check the points and crossings thoroughly and to get the defects rectified, if any. (6) He is to inspect the station yards and arrange for their up keep. (7) He is to keep all the records of programme to rectify the defects, to make renewals and progress of maintenance work. (8) He is to prepare the estimates of the maintenance works. (9) He is to take care of the materials under his charge and to maintain their proper account. (10) He is to take care of his staff members and to arrange for welfare and regular payment. (11) In the absence of Assistant Engineer, he is to perform his duties also. Following are the duties of <u>gang mate</u> : (1) He is responsible for general up keeping of the railway track in his section. (2) He is to arrange for tools and other equipments required by his gang. (3) He is to keep in view all the details and their condition in his section. (4) He is to check the points and crossings. (5) He is to allot specific duty to each of his gang men and to check his work. (6) He is to check if there is any unauthorized construction work done by any one in his section. He should report all such matters to his officer immediately. (7) In emergency, he is to check the movements of trains by showing temporary signals. In such cases, he should inform immediately his officer. (8) In case of an accident, he should see that rolling stock, broken fittings and track components are not disturbed or dislocated, till they are seen and recorded by some	(4 M)  2 M for any Four (1/2 Mark each)  2 M for any Four (1/2



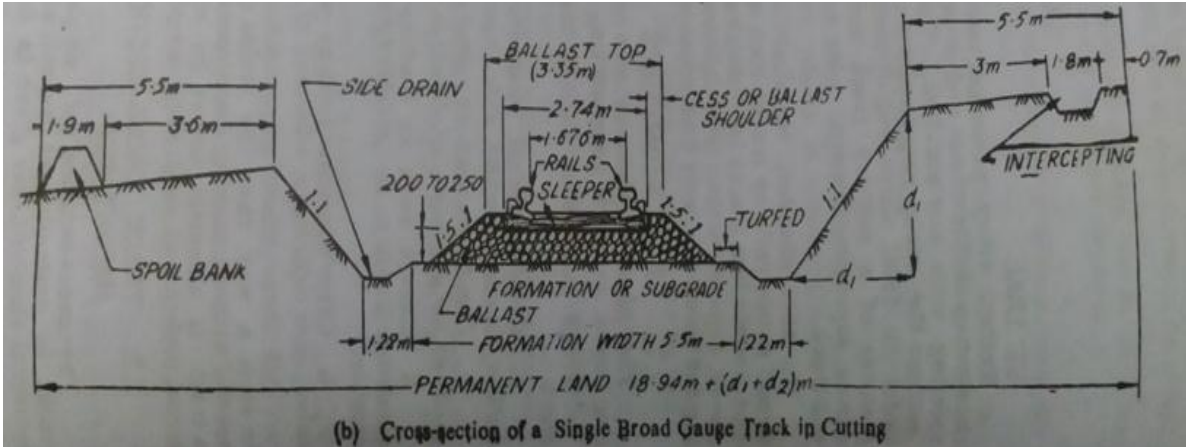
		responsible person. (9)He is to maintain a complete record of works, reports of key man etc. (10)He is to, often carry some miscellaneous duties like loading or unloading of materials, repairing fences, cutting branches of trees to make clear vision of signals, noting high flood levels of bridges and culverts etc. in his section.	Mark each)
2	(d) Ans.	<b>State the factors affecting selection of site of a bridge.</b> The following factors affects for selection of site of a bridge: (1) <u>A well defined and narrow channel</u> – The stream at the bridge site should be well defined and as narrow as possible. (2) <u>A straight reach</u> – There should be a straight reach of stream at bridge site. (3) <u>Good foundation bed at a short depth</u> – A good unyielding and non-erodable bed should be available at a short depth for providing foundation of abutments and piers of the bridge. (4) <u>Suitable high banks</u> – The stream at bridge site should have permanent, firm, straight, and high banks. (5) <u>Angle of crossing</u> – The axis of stream at bridge site should be crossing at right angles to the centre line of the communication route as far as possible. (6) <u>Absence of scouring and silting</u> – There should be no scouring and silting of the stream at bridge site. (7) <u>Location of river tributaries</u> – The bridge site should be away from the point of influence of large tributaries as far as possible. (8) <u>Minimum obstruction to waterway</u> – There should be minimum obstruction to natural waterway at the site of bridge. (9) <u>Sound, economical and straight approaches</u> – The bridge site should provide sound, economical and straight approaches. (10) <u>Absence of costly river training works</u> – The stream at bridge site should be free from costly river straining works. (11) <u>Minimum construction work inside water</u> – The stream at bridge site should be such that no excessive work is required to be carried inside the water. (12) <u>Proximity to the alignment of communication route</u> – The bridge site should provide proximity to the direct alignment of the communication route to be served. (13) <u>Availability of sufficient freed board</u> – If the river is used for navigation purpose, the bridge site should be such that sufficient free board should be available for the passage of boats, streamers or ships under the bridge superstructure. (14) <u>Availability of labour and constructional materials</u> – There should be easy availability of cheap labour, constructional materials and transport facilities near to the bridge site.	(4 M)  4 M (any eight ½ mark each)
2	(e) Ans.	<b>Define :</b> <b>(i) Effective span</b> <b>(ii) Clear span</b> <b>(iii) Economical span</b> <b>(iv) Waterway</b> <b>(i) Effective span:</b> - The centre to centre distance between any two adjacent supports of the bridge superstructure is called effective span or simply span. <b>(ii) Clear span:</b> - The clear distance between any two adjacent supports of the bridge superstructure is called clear span. <b>(iii) Economical span:</b> - The span for which the total cost of a bridge is minimum is known as	(4 M)  4 M (1 Mark)

		<p>economical span.</p> <p><b>(iv) Waterway:</b> - The sectional area at the site of a bridge through which water flows is termed as waterway.</p>	each)
2	(f) Ans.	<p><b>Define culvert. Enlist type of it and draw a sketch of any one.</b></p> <p><b>Culvert :</b> A small bridge having total length of 6 m or less between the faces of abutments is known as culver.</p> <p><b>Types of Culvert :</b> The following are the different types of culvert :</p> <ol style="list-style-type: none"> <li>(1) Arch culverts</li> <li>(2) Open or slab culverts</li> <li>(3) Pipe culverts</li> <li>(4) Box culverts</li> </ol> <p><b>(1) Arch culvert:</b></p>  <p><b>(2) Open or slab culvert:</b></p>  <p><b>(3) Pipe culvert:</b></p>  <p><b>(4) Pipe culvert:</b></p>	<p>(4 M)</p> <p>1 M</p> <p>2 M (1/2 mark each)</p> <p>1 Mark for any one diagram</p>



3  
(a)  
Ans.

**Attempt any TWO of the following:**  
**Draw a neat cross section of Broad Gauge (B.G.) single track in cutting and label its parts.**  
Cross Section of Broad gauge(B.G.) single track in cutting:



(16 M)  
(8 M)  
  
4 Marks  
for  
diagram  
&  
4 Marks  
for  
labeling  
  
8 M

3  
(b)  
Ans.

**Explain the types of gradient in railway track.**  
The types of gradient are as follows:  
**(1) Ruling Gradient :** The permissible gradient usually provided in a railway track, is known as ruling gradient.  
This is the maximum permissible gradient to which a railway track may be laid in a particular section. Ruling gradient mainly depends upon the power of the locomotive which shall be able to pull up the train load along the gradient.  
**(2) Momentum gradient :** The rising gradient on which a moving train takes the advantage of the preceding falling gradient in developing the momentum and kinetic energy for its negotiation is called momentum gradient.  
For example, in valley, a falling gradient is usually followed by a rising gradient.  
**(3) Pusher Gradient :** The gradient which requires one or more additional locomotives for pulling the train up the track is called pusher gradient.  
These gradients are always steeper than the ruling gradient. This type of gradient is very important on tracks in mountainous regions to avoid heavy cutting through rocks and to reduce the route length.  
**(4) Station yard gradient :** The gradient provided in station yards for easy drainage is known as station yard gradient or minimum gradient.  
In station yards, gradients are avoided as far as possible due to the following reasons:  
(i) Bogies standing on gradients are liable to move under the effect of heavy winds and may cause accidents.  
(ii) The locomotives will require extra force to pull the train up a gradient while starting the train.

(8 M)  
  
2 Marks  
  
2 Marks  
  
2 Marks  
  
2 Marks

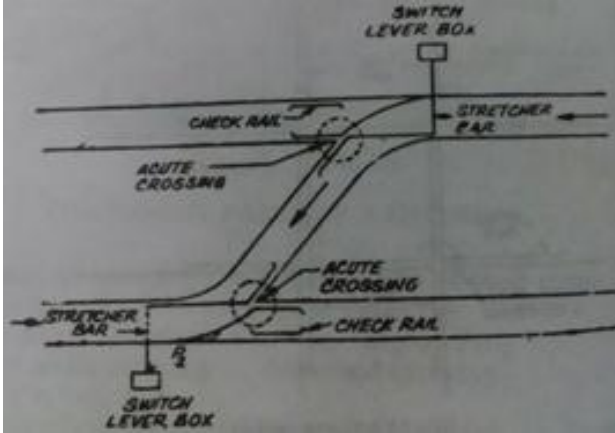
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(c) Draw a neat line sketch of the following:

- (i) Cross over
- (ii) Scissor crossover
- (iii) Diamond crossing
- (iv) Triangle

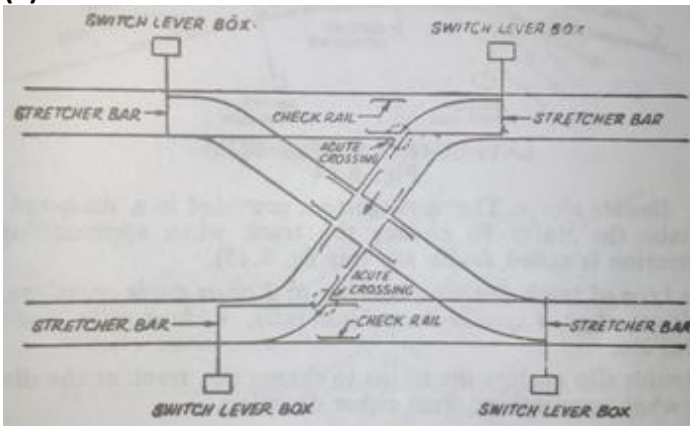
(8 M)

Ans. (i) Cross over :-



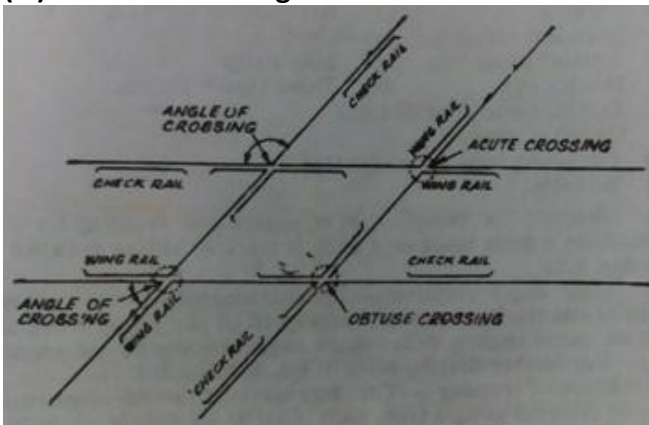
2 Marks

(ii) Scissor crossover :-



2 Marks

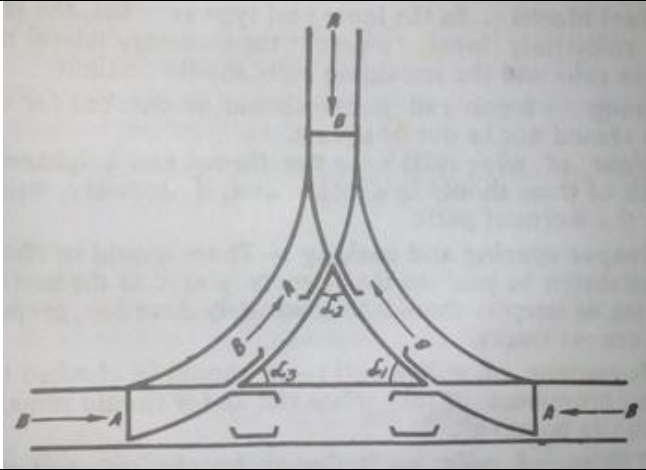
(iii) Diamond crossing :-



2 Marks

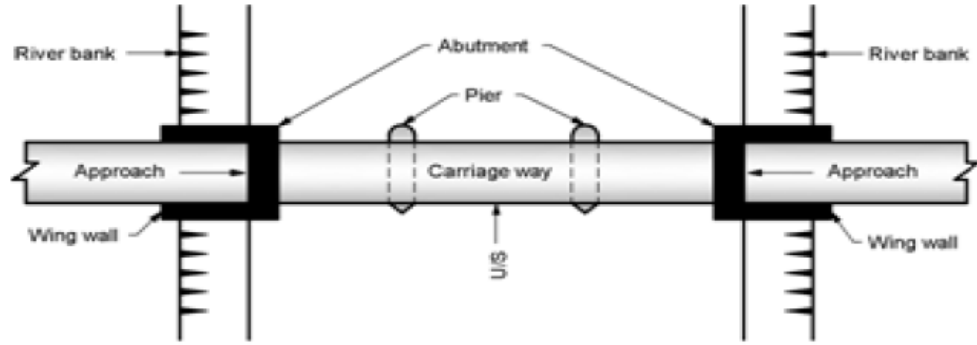
(iv) Triangle :-



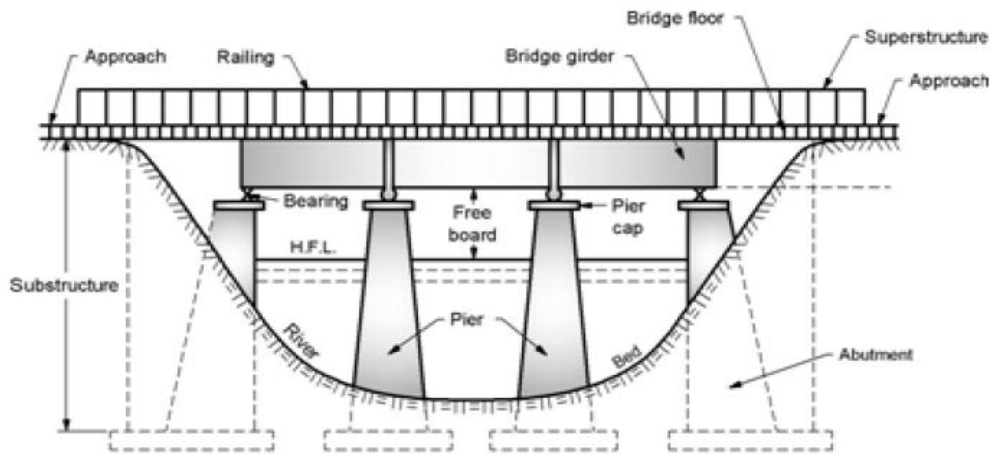


2 Marks

Que. No.	Sub Q.N.	Answer	Marking Scheme
4		<p>Attempt any <b>TWO</b> of the following :</p> <p><b>(a) Classify the bridges according to function, material, span and Alignment.</b>  <b>Ans:</b> Bridges can be classified into various types depending upon the Following factors and condition.</p> <p><b>I. According to functions:</b></p> <ol style="list-style-type: none"> <li>Aqueduct</li> <li>Viaduct</li> <li>Foot bridge</li> <li>Highway bridge</li> <li>Railway bridge</li> </ol> <p><b>II. According to material:</b></p> <ol style="list-style-type: none"> <li>Timber bridge</li> <li>Masonry bridge</li> <li>Steel bridge</li> <li>Reinforced cement concrete bridge</li> <li>Pre stressed concrete bridge</li> </ol> <p><b>III. According to span length:</b></p> <ol style="list-style-type: none"> <li>Culvert</li> <li>Minor bridge</li> <li>Major bridge</li> <li>Long span bridge</li> </ol> <p><b>IV. According to alignment:</b></p> <ol style="list-style-type: none"> <li>Straight bridge</li> <li>Skew bridge</li> </ol>	<p><b>(16 M)</b></p> <p><b>8 M</b></p> <p>2 M</p> <p>2 M</p> <p>2 M</p> <p>2 M</p>
	<b>(b)</b>	<p><b>Draw plan and Sectional elevation of Bridge showing all important component parts.</b></p>	<b>(8 M)</b>
	<b>Ans.</b>		



(a) Plan



(b) Section

( 2 Mark for diagram and 2 mark for labelling)

( 2 Mark for diagram and 2 mark for labelling)

(c) State the functions of bridge bearing and also State the types of bridge bearings with neat sketches.

(8 M)

Ans. Function of bridge bearing:

1. To distribute the load received over large area.
2. To allow for longitudinal expansion or contraction due to changes in the temperature.
3. To allow for angular movement at support due to deflection of girders.
4. To allow for vertical movement due to sinking of supports.
5. To transfer horizontal forces occurring due to application of brakes to the vehicle etc.
6. To keep the compressive stress within safe limits.

1 M each  
(any two)

**Types of Bearing:**

**A. Fixed Bearing:**

1. Fixed Plate Bearing
2. Deep Base Bearing
3. Rocker Bearing
4. Knuckle Bearing

2 M

**B. Expansion Bearing:**

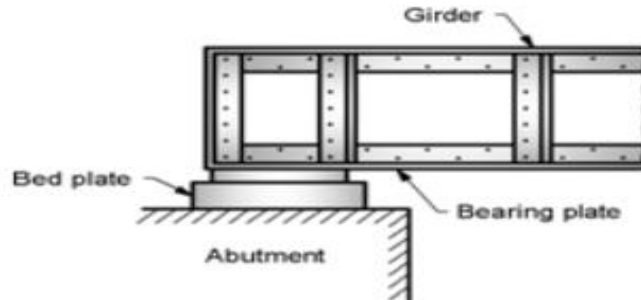
1. Sliding Plate Bearing
2. Deep cast with curve plate

2 M

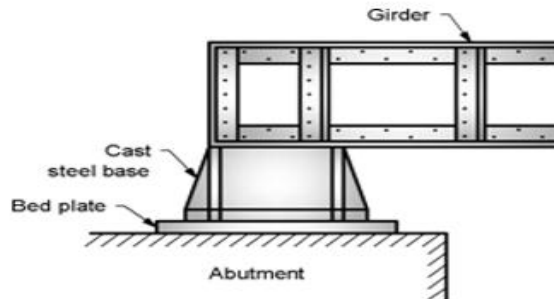
- 3. Rocker bearing with curved base
- 4. Rocker & roller bearing

**A. Fixed Bearing:**

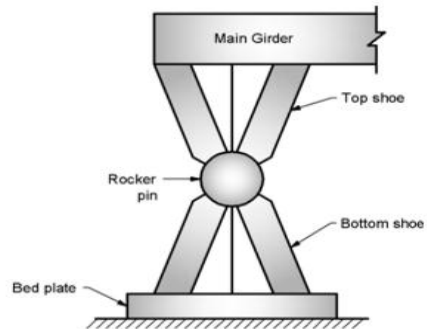
**1) Fixed Plate Bearing:**



**2) Deep Based Bearing:**

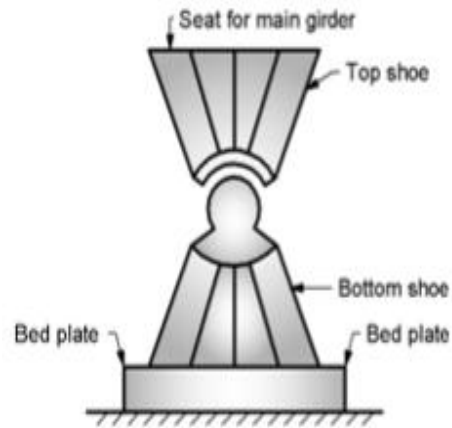


**3. Rocker Bearing**



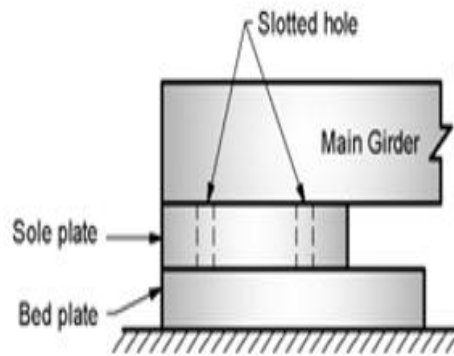
**4. Knuckle Bearing**

2 M (any one Dia.)  
1 M for Diagram  
1 M for labelling

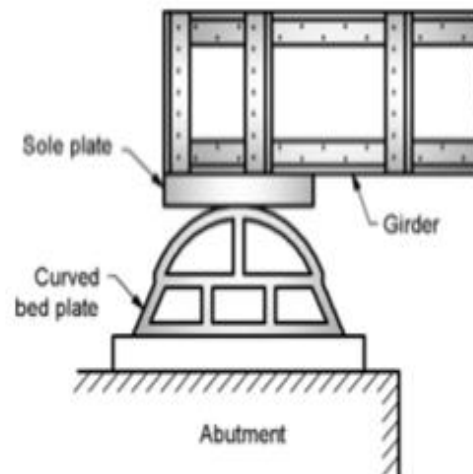


## B. Expansion Bearing

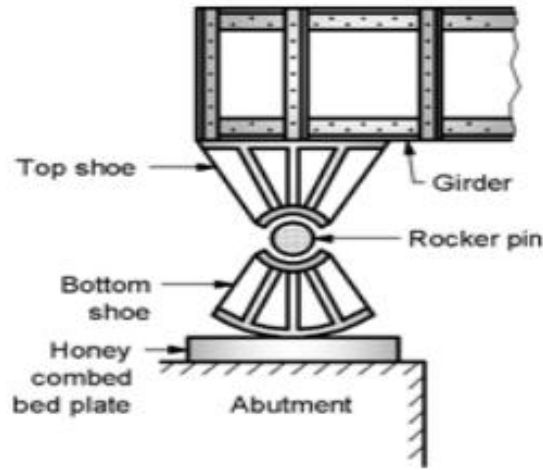
### 1. Sliding Plate Bearing



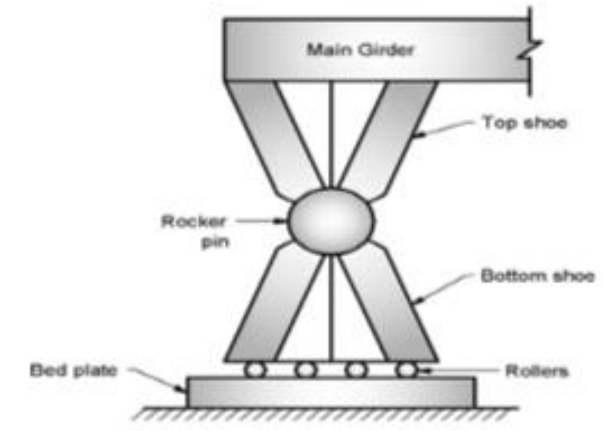
### 2. Deep cast with curve plate



### 3. Rocker bearing with curved base



4. Rocker & roller bearing



5

Attempt any Two of the following:

(a) Classify the tunnels according to shape and size, position of alignment, materials and purposes, with necessary suitable sketches.

Ans.

According to the size and shape:

1. Rectangular or box type shape
2. Circular shape
3. Segmental shape
4. Horse shoe shape
5. Egg type shape
6. Elliptical shape
7. Poly – centric shape

(Note: 1 mark for type of tunnel and 1 mark for sketch.)

According to the position of alignment:

(16 M)

8M

2 marks each (Any two)

1. Saddle and base tunnels
2. Spiral tunnels
3. Off spur tunnels
4. Slope tunnels

1 mark  
(Any two)

**According to the type of material:**

1. Tunnels in hard rock
2. Tunnels in soft rock
3. Tunnels in quick sand
4. Tunnels under river bed

1 mark  
(Any two)

**According to the purpose:**

1. Traffic tunnel :

- a) Railway tunnels
- b) Highway tunnels
- c) Pedestrian tunnels
- d) Navigation tunnels
- e) Subway tunnels

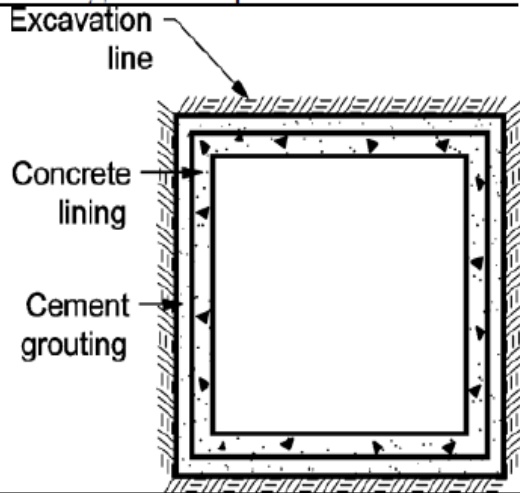
1 mark  
(Any two)

2. Conveyance tunnel :

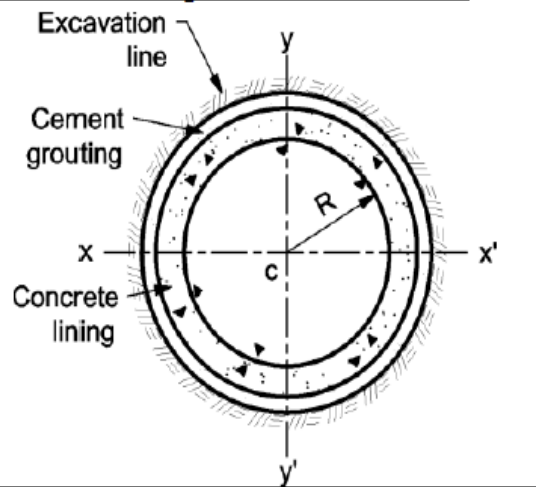
- a) Hydro power tunnels
- b) Water supply tunnels
- c) Sewage tunnels
- d) Tunnels for industrial use

1 mark  
(Any two)

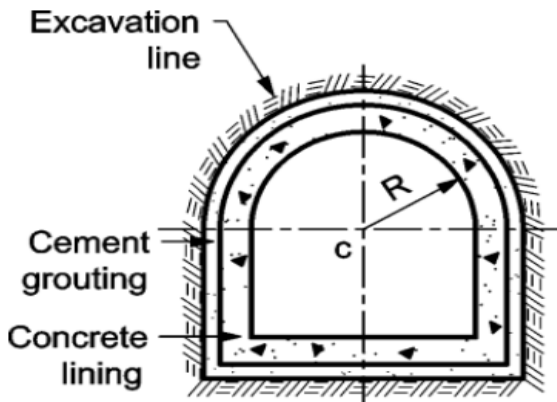
Rectangular shaped tunnel section



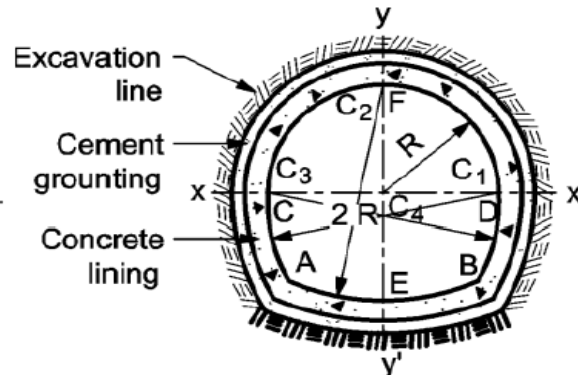
Circular shaped tunnel section



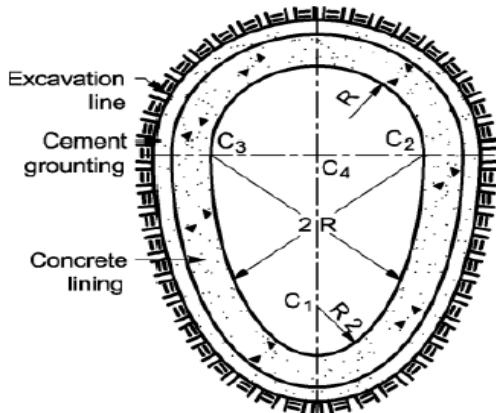
Segmental shaped tunnel section



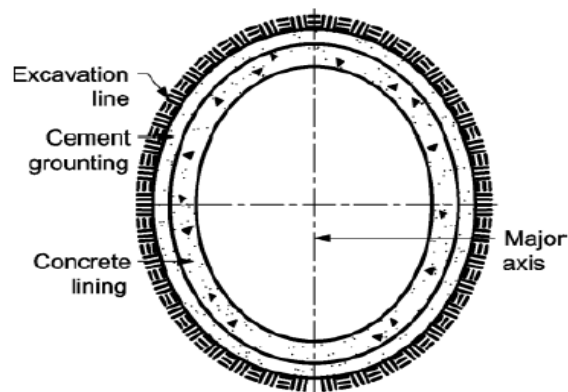
Horse-shoe shaped tunnel section



Egg-shaped tunnel section



Elliptical shaped tunnel section



5

(b)

State the methods of tunneling in soft rock and hard rock. Explain any one method with neat sketch.

(8M)

Ans.

**The various methods for tunneling in soft rock are: –**

- i) Needle beam method
- ii) Fore-poling method
- iii) Line plate method
- iv) Shield method

2 M  
(1/2 M for each)

**The various methods for tunneling in hard rock are: -**

- (i) Full – face heading method
- (ii) Heading and bench method
- (iii) Drift method

2 M

**Methods for tunneling in soft rock:-**

**i) Needle beam method**

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

4 Mark  
(any one method)

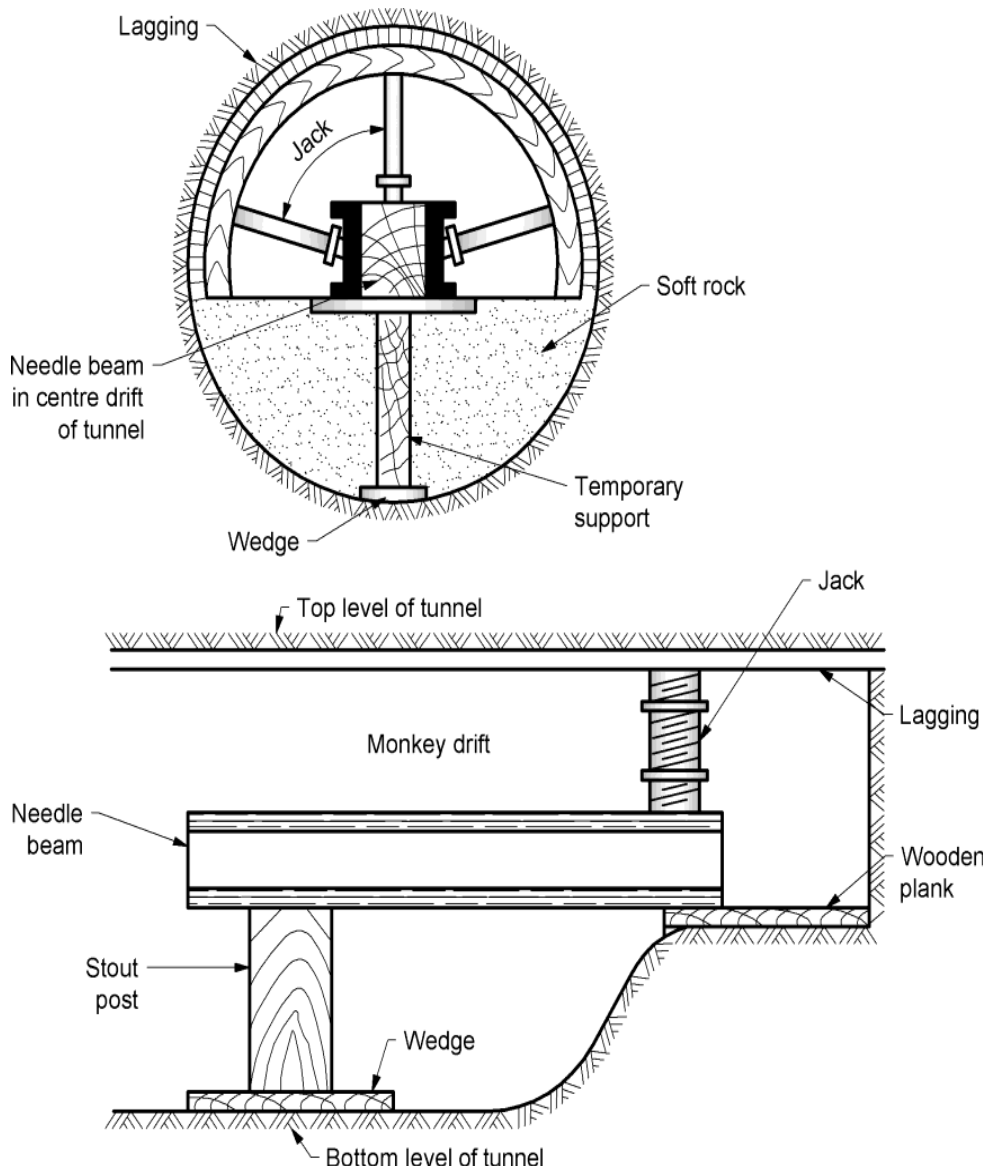
**Construction steps :**

(a) First of all a small drift of about 1m x 1m 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  
(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.

□ Advantages of needle beam method :

- (i) This method is economical.  
(ii) Brick lining can be easily done by this method.



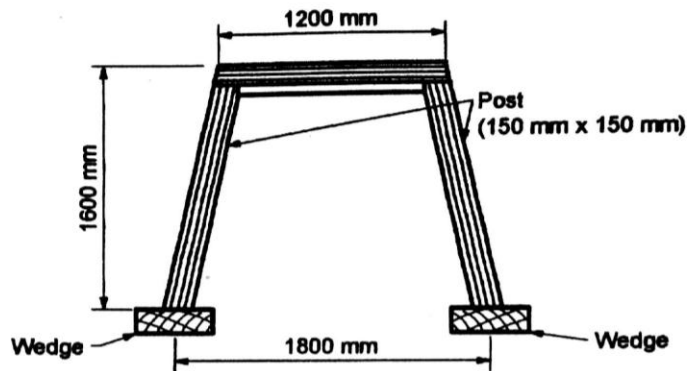
**ii) Fore-poling method-**

It is an ancient method of tunneling, but now it has been replaced by compressed air method. This method needs large quantity of timber for supporting the ground. This method is used for the construction of small dimensions tunnels required for laying sewers, gas, pipes etc. it is slow and tedious.

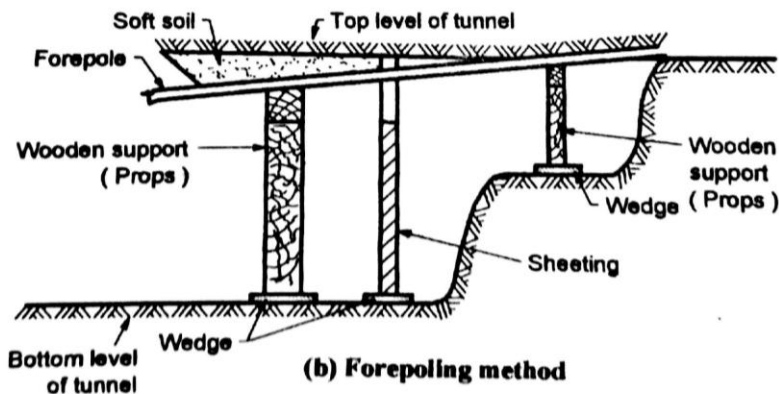
Construction steps:-



- 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 upto which they can be easily taken up.
- These poles are supported by vertical 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.



(a) Front view



(b) Forepoling method

### iii) Line plate method-

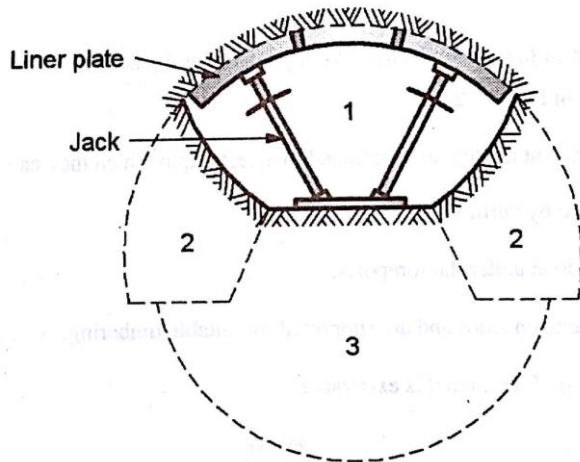
- In line plate method, timbering is replaced by standard sized pressed steel plates.
- The pressed steel plate is of 40 cm wide and 90 cm with all four edges flanged over 5 cm.

#### Construction steps:-

- In this method, first of all 40 cm deep hole is cut.
- Roof is trimmed carefully and crown plate is set.
- The excavation is then widen out and the adjacent plates set on each side as shown in fig.
- If there is any ground pressure on the plates, the plates are supported with the help of jack

#### **Advantages-**

- The line plates are light, hence handled easily.
- Unskilled labours can also erect the line plates.
- They are fire proof, hence they can be used safely.



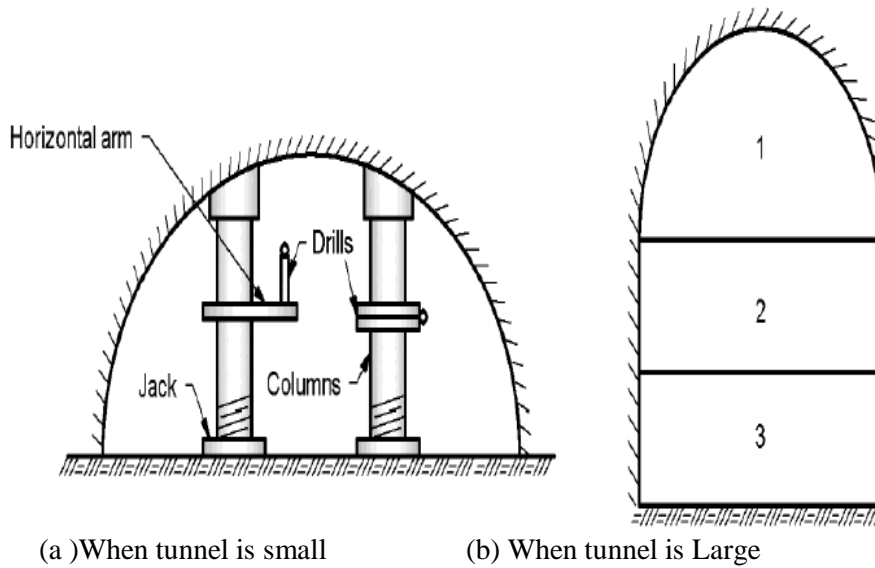
**iv) Shield method:-**

- Shield method of tunnelling has now become more popular than old methods.
- The latest development in tunneling is the invention of mechanical tunneler called mole.
- Mole is a machine which has number of steel grinding discs on its surface.
- This disc rotates at high speed to cut the soft rock or ground.
- This machine also moves forward leaving behind full size of the tunnel.
- Shield method do not require use of timbering.

**Methods for tunneling in hard rock: -**

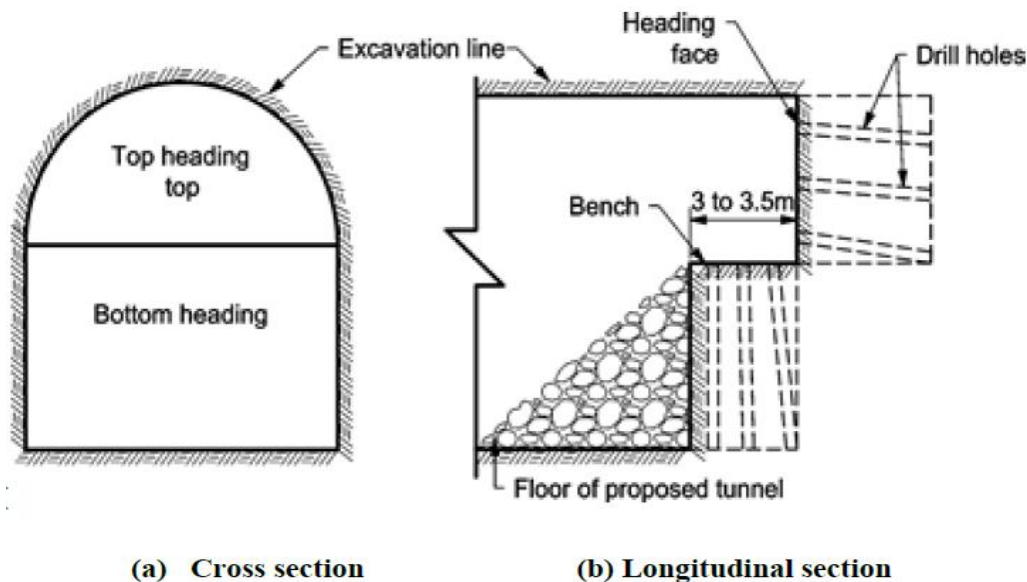
**(i) Full - face heading method :**

- As in this method whole section of the tunnel is attacked at the same time, this method is called as full - face heading methods.
- In this method, vertical columns are fixed at the face of the tunnel and drilling is done on the whole section of the proposed tunnel.
- The drill holes are charged with explosive and ignited at a time.
- The size of the hole may vary from 10mm to 40 mm.
- The muck is removed before the next operation of drilling holes.
- Tunnel Boring Machine are well suited for full face method



**(ii) Heading and bench method**

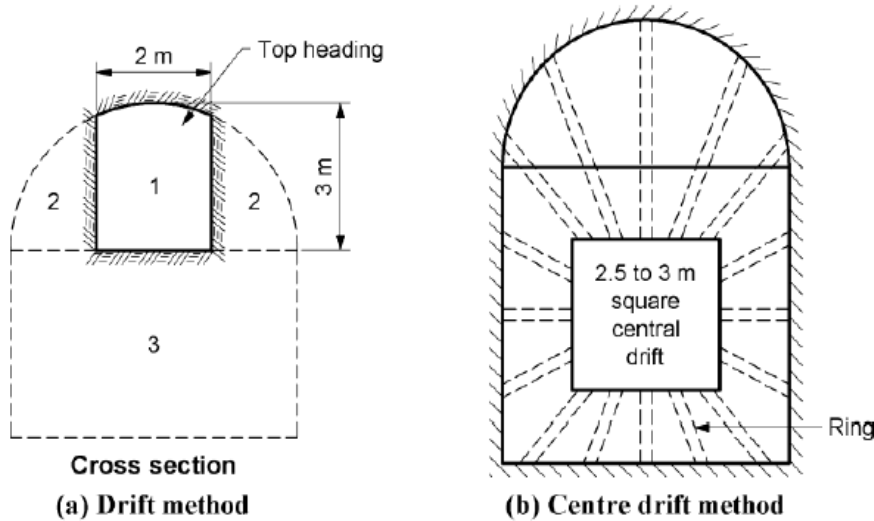
- In this method, the driving of the tunnel is done in two portions of its section.
- The top portion is known as heading and bottom portion is known as bench.
- The driving of top portion is done in advance of the bottom portion as shown in Fig. 4.8.2.
- In this method of tunneling the top portion or heading will be about 3 to 3.5 m ahead of the bottom portion as shown in Fig. 4.8.2.
- The holes are drilled into head and bench.
- Then these holes are loaded together with explosive and then blasted.
- Firing of bench holes is done just before the heading holes are fired.
- After this mucking is done manually.



**(iii) Drift method**

- 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 center heading of drift.
  - (ii) Widening and enlarging.

- (iii) Benching in stages.
- In this method, a drift of 2.5 m x 3 m (minimum) size or sufficient to accommodate the tunneling 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.



(Note: - 4 M for any one method above. 2M for explanation and 2M for Dia.)

**5 (c) Define “Tunnel ventilation”. State two purposes of it. Enlist method of ventilation of tunnel and explain any one.**

**(8 M)**

**Ans.**

**Tunnel ventilation:**

The art of providing freshness of air inside tunnels during or after their construction is known as ventilation in tunnels.

**Purpose of tunnel ventilation:**

1. To supply fresh air inside the tunnel.
2. To remove poisonous gases, dust smoke etc.
3. To reduce temperature in tunnel situated at great depth.
4. The traffic moving in a tunnel after its construction produces smoke, foul gases which may cause suffocation and inconvenience to the passengers if the tunnel is not properly ventilated.

**Methods of tunnel ventilation are as follows; -**

1. Natural method
2. Mechanical method

**(1) Natural method :**

- Natural ventilation is possible automatically due to difference of temperature inside and outside the tunnels.
- Good ventilation is not possible by this method.
- Natural ventilation can be improved by providing shafts at a suitable interval along the alignment of a tunnel during its construction.

**This method is suitable when :**

- (a) Tunnel is to be laid in the direction of wind.
- (b) A drift is driven from portal to portal.

1 M

1M each  
(Any two)

1 M

(4 M for any one method)



(c) Diameter of the tunnel is large but its length is small.

**(2) 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 :

- (i) Blowing process
- (ii) Exhausting process
- (iii) Combination of blowing and exhausting

**(i) Blowing process :**

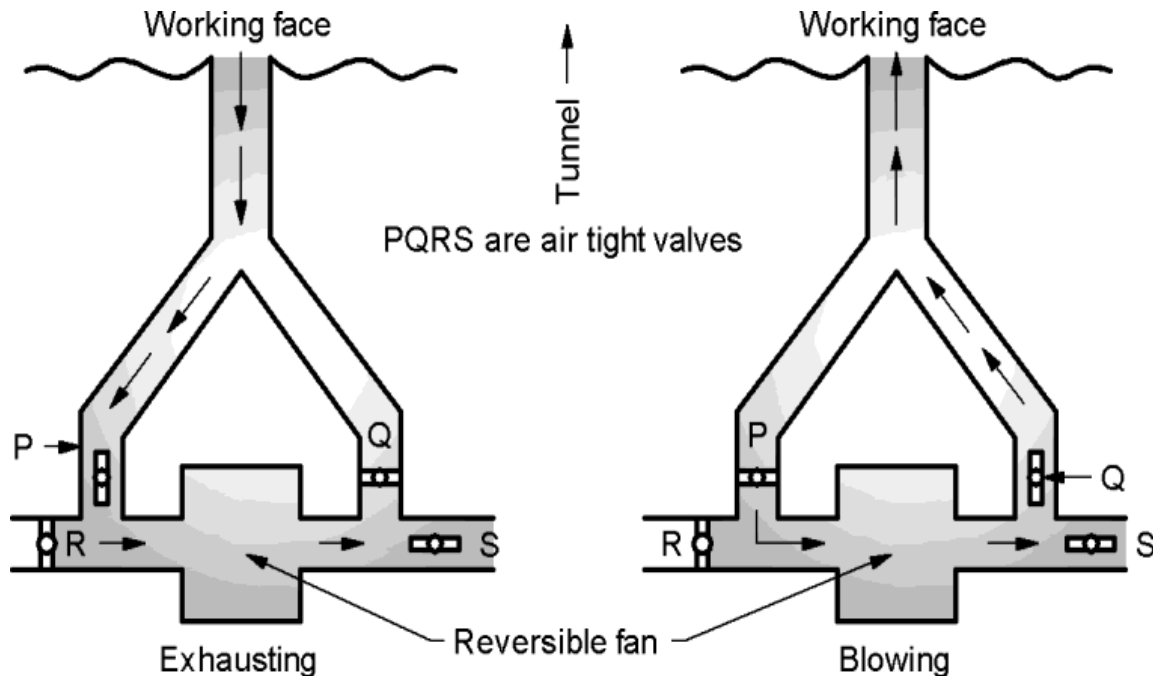
- In this method of mechanical ventilation, fresh air is forced by one or two blowers through the ducts, provided in the tunnel.
- By this method, positive supply of fresh air at the working place can be obtained.
- But the disadvantage lies in that the foul air, smoke and dust slowly move out, fogging the atmosphere inside the tunnel, especially in long tunnels.
- This method is also known as propulsion method.

**(ii) 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.

**(iii) 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.
- Immediately after the blasting operation, the exhausting system is operated for 15 to 30 minutes, to remove the objectionable air.
- After which blowing system is operated for forcing fresh air in the tunnel.
- This method provides the most efficient ventilation system of tunnels.



Combination of blowing and exhausting process

( Note – 4 Marks for any one method above )

6

Attempt any **FOUR** of the following:

(16 M)

(a) Explain marshalling yard with a neat sketch. Also state its types

(4 M)

Ans. **Marshalling Yard:-**

The yards where trains and other loads are received, sorted out station wise and new trains are formed and dispatched onwards are known as marshalling yards.

1 M

In a marshalling yard, loaded and empty goods wagons are first received from different lines for booking to different destination stations. Then these wagons are separated, sorted and dispatched in full trains in each line. While making full trains, the wagons are arranged in order of the stations so that they can be detached conveniently at the required stations.

▪ **Functions of marshalling yards:-**

- i. Reception of empty and loaded wagons
- ii. Sorting of wagons
- iii. Departure of wagons in the form of trains.

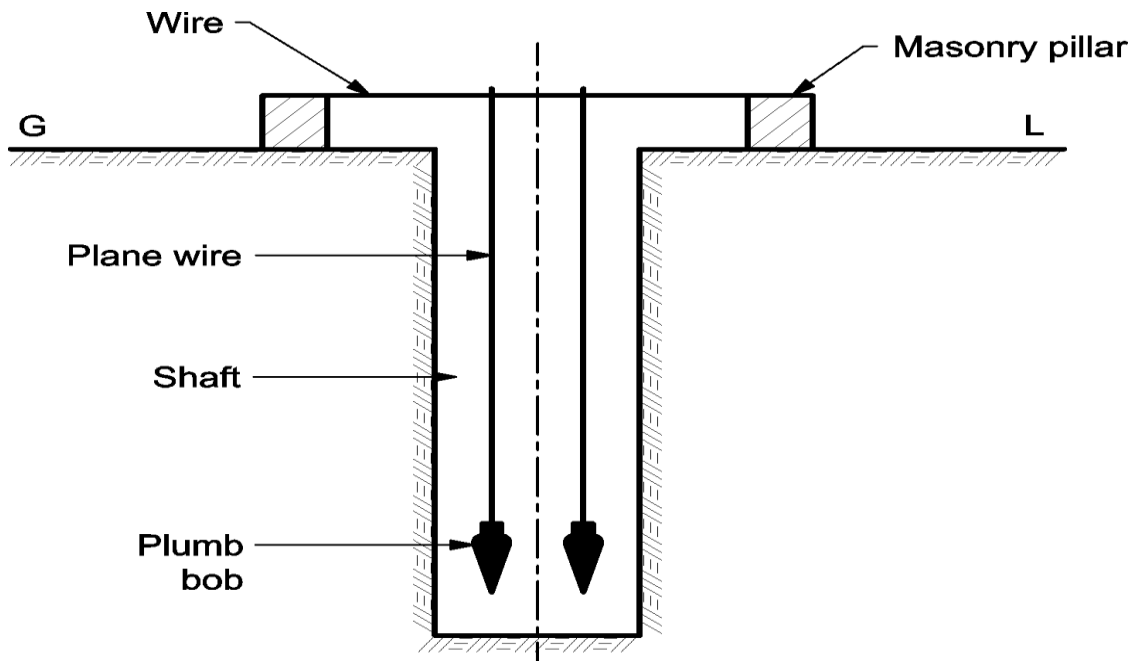
• **Types of marshaling yards:-**

- i. Flat yards
- ii. Gravitational yards
- iii. Hump yards

1 M  
any Two

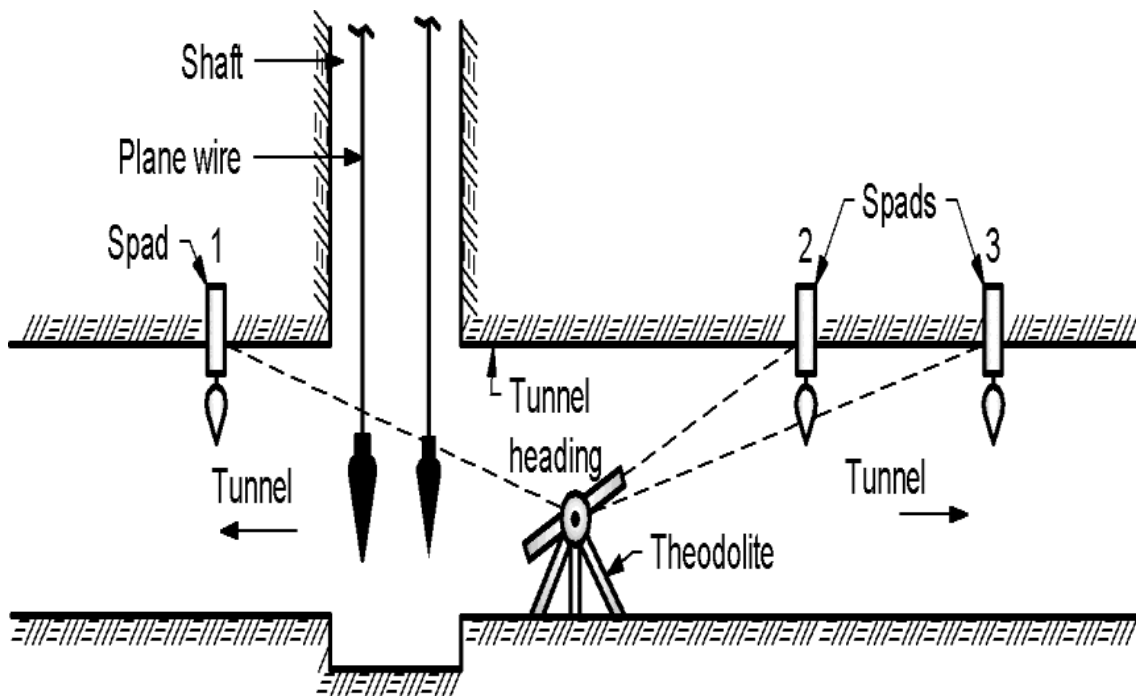
		<p style="text-align: center;"><b>LAYOUT OF A MARSHALLING YARD</b></p>	<p>2M (1M for diagram 1 M for labelling)</p>
6	(b)  <b>Ans.</b>	<p><b>State any two advantages and disadvantages of tunnel.</b></p> <p><b>Advantages:</b> Following are the advantages of providing tunnels.</p> <ol style="list-style-type: none"> <li>1. They carry railway lines, roads and public utilities like water, oil, gas etc., across streams or mountains, economically.</li> <li>2. They eliminate excessive cost of maintenance of an open cut Subjected landslides.</li> <li>3. They connect the two terminal stations by the shortest route.</li> <li>4. They help in avoiding holding up of traffic for long periods due to traffic congestion and provide rapid transportation in big cities.</li> <li>5. They help in avoiding acquisition of costly land and, property for a railway or road projects.</li> <li>6. They provide protection to the railway track or road pavements from the effects of rain and other weathering agencies and thus Require less maintenance.</li> <li>7. They provide free movement of traffic throughout the year even during snowfall and landslides.</li> </ol> <p><b>Disadvantages:</b> Following are the disadvantages of providing tunnels.</p> <ol style="list-style-type: none"> <li>1. They may be costlier in construction as compared to open cut</li> <li>2. They require more time in their construction as compared to open cut</li> <li>3. They require special equipment and methods for their construction.</li> <li>4. They require skilled labour and supervision in their construction</li> <li>5. They may cause suffocation if not properly ventilated and thus, result inconvenience to the passengers.</li> </ol>	<p>(4 M)</p> <p>2 M (any Two)</p> <p>2 M (any Two)</p>
6	(C) <b>Ans.</b>	<p><b>Explain in brief process of transferring center line inside the tunnel with a neat sketch.</b></p> <p>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</p>	<p>(4 M)</p> <p>2 M</p>

bobs, fixed to the roof of the tunnel as shown in figure.



(a) Transferring the alignment (centre line) at the bottom of the shaft

1 M



(b) Transferring the alignment to inside of the Tunnel

1 M

6 (d) Define "shaft". State the purpose of providing shaft in tunnel.

(4 M)

Ans.

**Definition:-**

The vertical wells or passages constructed along the alignment of a Tunnel are known as shafts.

1M



**Purpose of providing shaft;-**

- 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.

1 M each  
(any 3)

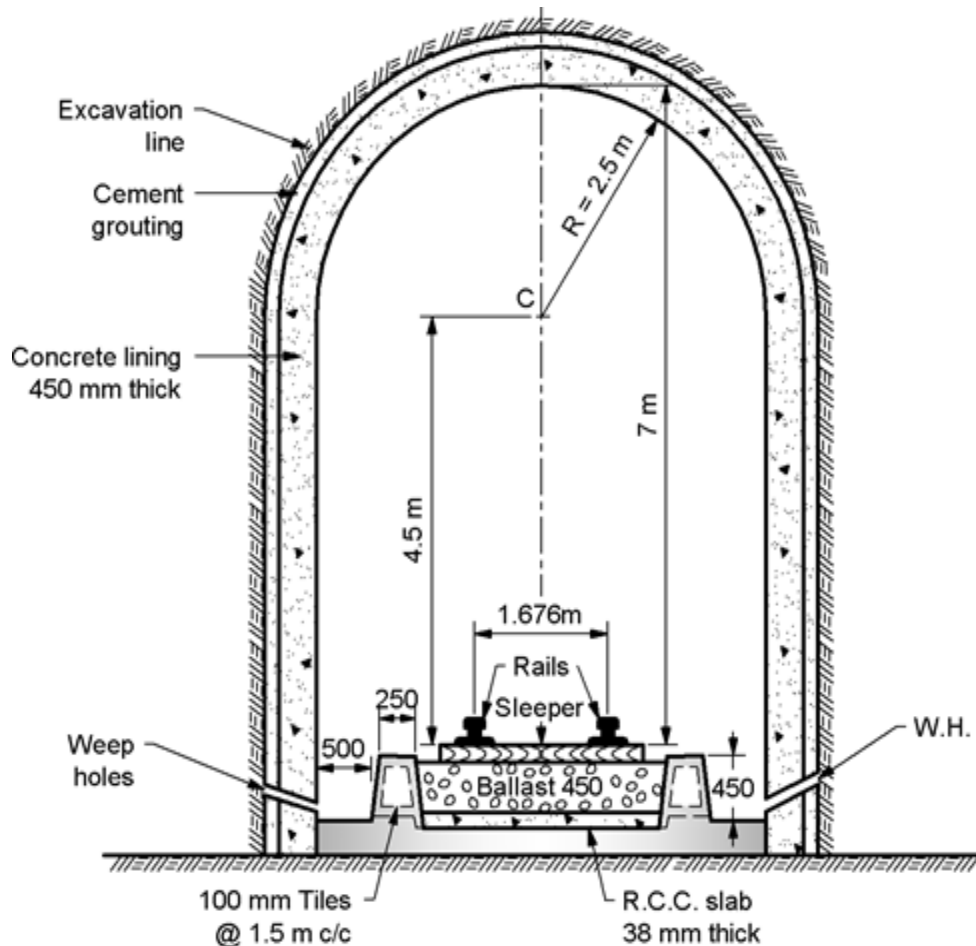
6

(e)

**Draw tunnel cross section of railway track.**

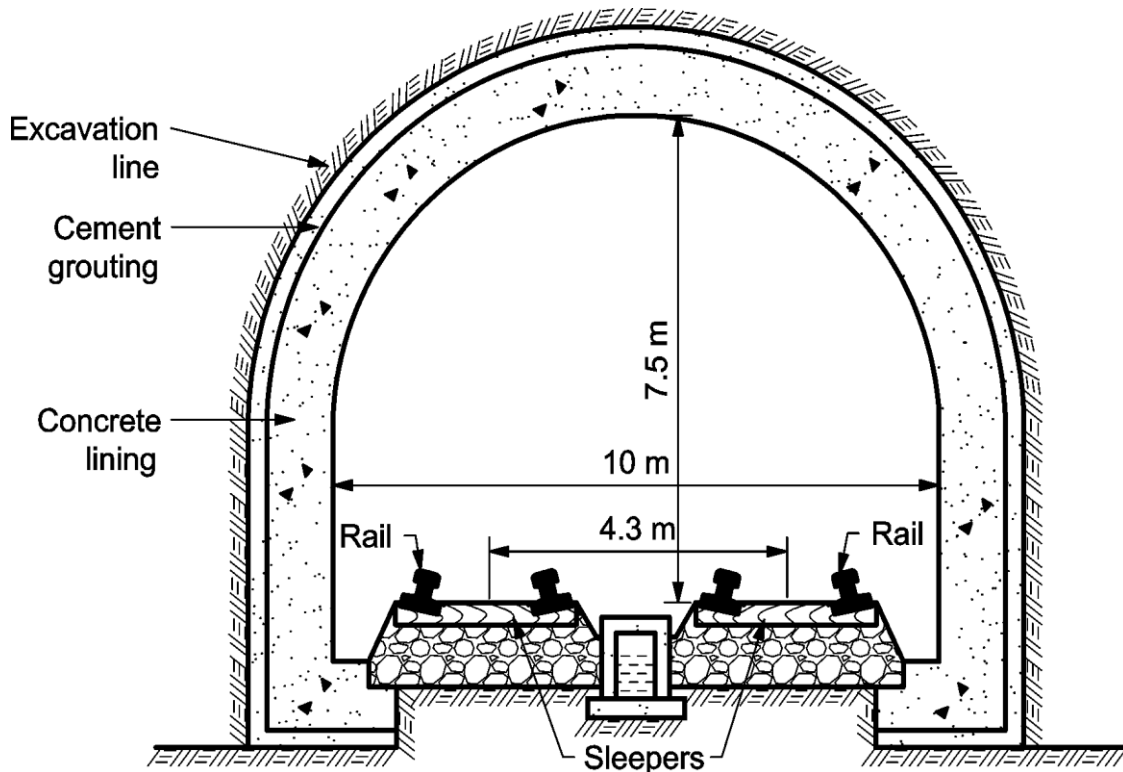
(4 M)

Ans.



Cross-section of tunnel for a single line broad gauge railway track

(3 marks  
for sketch  
and  
1 mark for  
labelling )



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

(Note- any one diagram from the above should be considered)

6

f

State the types of drilling equipment's and explosives used in tunneling.

**Drilling equipment's are divided into two types-**

- (1) Drill
- (2) Drill carrying equipment's

**Types of Drills:**

- a) Jack Hammer
- b) Drifters

**Drill Carriage equipment-**

- a) Support for mounting drills
- b) Drill carriage
- c) Drill jumbo

**Types of Explosives used in tunneling -**

- (1) Disruptive explosive
- (2) Power explosive
- (3) Liquid air explosive

(4M)

1M

1M

1M

1M