



# MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

(Autonomous)

(ISO/IEC-270001 – 2005 certified)

SUMMER-14 EXAMINATION

**Subject code: 17418**

**Model Answer**

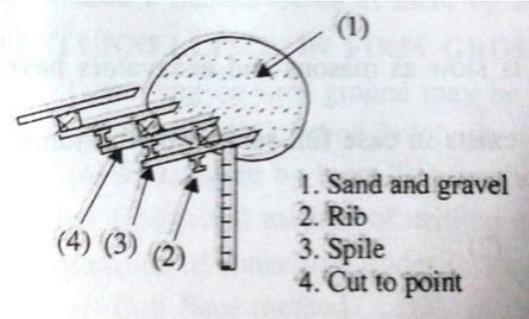
**Page No: 1/16**

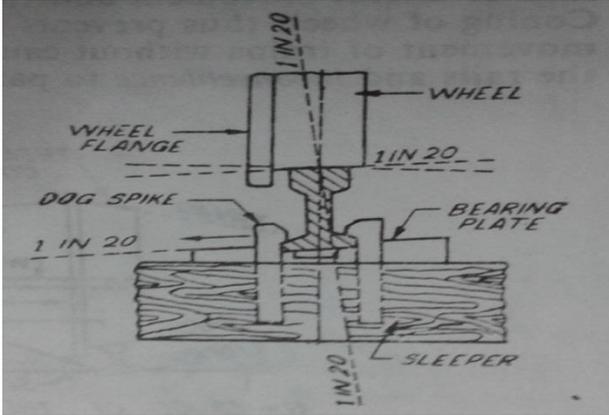
## **Important Instructions to examiners:**

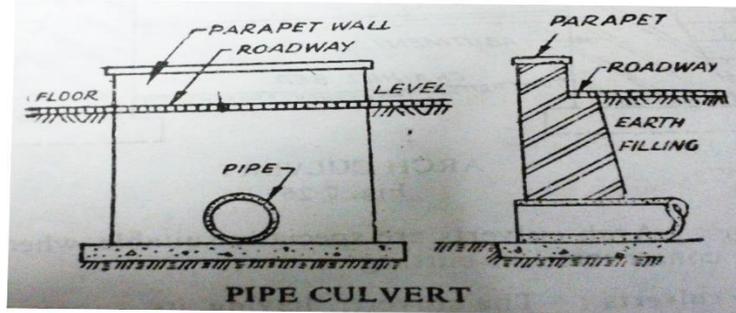
- 1) The answer should be examined by keywords and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language error such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skill).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figure 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 the some cases, the assumed constants values may vary and there may be some difference in the candidates answer and model answer.
- 6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding.

<b>Q.1.A) Attempt any SIX of the following.</b>	<b>12</b>
<b>i) State the role of transportation in the development of nation.</b>	
<b>Ans:-</b> Role of transformation is in the movement of people and goods within the nation and transformation of both people and given us feasible by land ,water and air .the transport by land is feasible through roadways and railways. Both this mode are easy and economical they play an important role in the economic and social and commercial development of a country,	02
<b>ii) State the important of cross drainage works for railways.</b>	
<b>Important of cross drainage works for railways are:</b>	
<b>i) To pass the rain water safely across the track</b>	01
<b>ii) To allow the communication or movement of people goods etc. traffic across the track.</b>	01

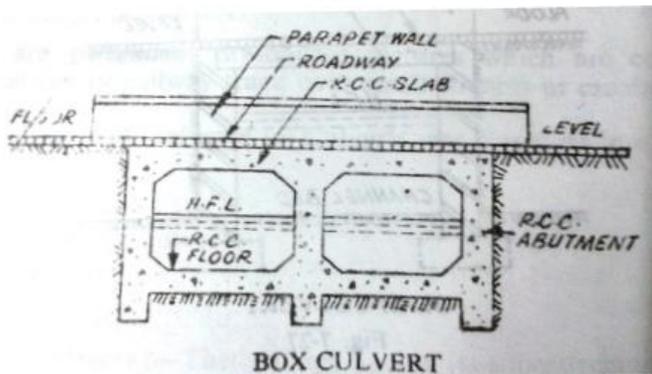
<b>iii) State the factors of governing rail alignment.</b>	
<ol style="list-style-type: none"> <li>1. Connecting tread centres.</li> <li>2. Strategic consideration.</li> <li>3. Shortening existing routes.</li> <li>4. Connecting port with the interior of the country.</li> <li>5. Lying of branch line.</li> </ol> <p style="text-align: right;"><i>*(1/2 mark each any four)</i></p>	*
<b>iv) State the type of gauges in railways.</b>	
<p>Following are the type of gauges.</p> <ol style="list-style-type: none"> <li>1. Broad gauge(B.G)</li> <li>2. Meter gauge(M.G.)</li> <li>3. Narrow gauge(N.G.)</li> </ol>	02 marks
<b>V) State the factors affecting the choice of transport.</b>	
<ol style="list-style-type: none"> <li>1. Quantity of material to be transport.</li> <li>2. Weight of the material to be transported.</li> <li>3. Distance of transport.</li> <li>4. Time available for transportation.</li> <li>5. Locations of places of transport.</li> </ol> <p style="text-align: right;"><i>*( 01 mark each any four)</i></p>	*
<b>Vi ) Define super elevation</b>	
The raised elevation of the outer rail above the inner rail at a horizontal curve in case a railway track is called super elevation.	02
<b>Vii) Define Negative cant.</b>	
<b>Negative cant:-</b> The elevation of outer rail below the inner rail of a turn out or branch at the place where it meets the main track on a curve is called negative super-elevation or negative cant.	02
<b>Viii) Define abutment and wing walls.</b>	
<b>Abutment:-</b> The end supports of a bridges superstructure are termed as abutments.	01
<b>Wing walls:-</b> The walls constructed on both sides of abutments to retain the earth banks of the river or of the bridge approaches are called wing wells.	01
<b>B) Attempt any Two of the following</b>	08
<b>I) Define Tunnel ventilation and state its objective.</b>	
<b>Tunnel ventilation:-</b> It can be defined as technics of providing freshness of air inside the tunnel during and after construction.	02
<b>Objectives of tunnel ventilation:</b>	
<ol style="list-style-type: none"> <li>1. To allow fresh air for the worker.</li> <li>2. To remove objectionable gases and the fumes produced by explosives.</li> <li>3. To remove the dust caused by drilling, Blasting, Mucking and other operations.</li> </ol>	02

<p><b>ii) Define fore –poling method of tunnel in soft rock.</b></p>	
<p>It can be define as the method of making a tunnel in a soft rock.</p> <p>The ground ahead is supported by boards driven as shown in fig. below the ribs are known asAs splices. Beyond the point breasting the fore pole at as cantilever. They carry the weight of the ground till there forwardness is supported by steel ribs. Piles as placed as far around the periphery as required the soil excavated after removing the breast boards. A new rib then erected in position. This operation is followed by fixing fresh breast boards and the sequence of operation is repeated.</p> 	<p>02</p> <p>02</p>
<p><b>iii) State the necessity of maintenance of Bridage.</b></p>	
<p><b>Necessity of maintenance of Bridage:-</b> Poor design and construction may result in worst problems for bridage maintenance.even if the bridges are well designed and constructed ,they may require perodic maintanance ,the extent of which would hower depend upon the bridge type ,Normally are service –life expectancy of a bridges is about 70 years for the superstrucuter and 100 years of the substructure .Due to faulty maintanance the usefull life of may be drastically reduced .In order to assure bridages safety and conserve the national investement on bridages ,it is essential to evolve and implement suitable inspection and evaluation procedures.</p>	<p>04</p>
<p><b>Q.2. Attempt any Four of the following:</b></p>	<p>16</p>
<p><b>a) What is tilting of rails? Explain with a neat sketch.</b></p>	
<p><b>Tilting of rails:-</b> The art of placing the rails of a track at an inward slop of 1 in 20 is called tilting of rails,</p> <p>In case the rail of track are placed in vertical position ,the top surface will not come vin full contact with the treads of wheels of a train due to coning of wheels and the pressure of wheels will always be exerted near the inner edges of the rails. Tilting of rails.Therefore, the rails will wear out quickly .To make full contact of top surface and thereby reducing the wear of rails in this way, these are placed at an inward slope of 1 in 20.which is known as tilting of rails.</p>	<p>02</p> <p>01</p>

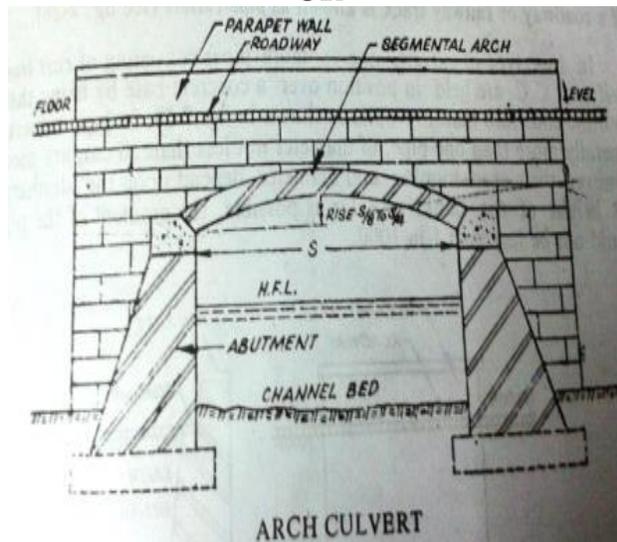
 <p><b>Tilting of rails</b></p>	<p>01</p>
<p><b>b) Explain factors governing the rail alignment.</b></p>	
<p><b>Connecting tread centres.:-</b> As per the locations of large cities for movement of goods rail alignment is provided.  <b>Strategic consideration.</b> For movement of defence material  <b>Shortening existing routes.</b> To achieve economy  <b>Connecting port with the interior of the country.</b>  <b>Laying of branch line.</b></p>	<p>04</p>
<p><b>c) State the type of culvert and draw a neat sketch of any culvert.</b></p>	
<p>Following are the different types of Culverts.</p> <ul style="list-style-type: none"> <li>i) Arch culvert</li> <li>ii) slab culvert</li> <li>iii) Pipe culvert.</li> <li>iv) Box culvert.</li> </ul>	<p>02</p>



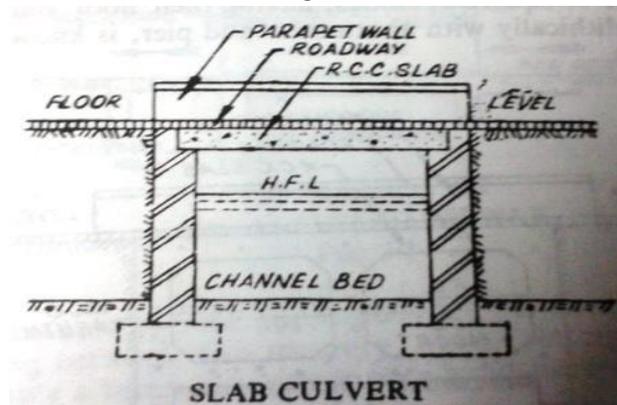
**OR**



OR



OR



OR

02  
mark  
sketch  
(any  
one)

d) Define tunnel lining and state its objectives.

“It can be defined as finishing touch to the tunnel cross section from inside of the tunnel is known as tunnel lining.”

**Objectives :** It is provided to achieve the following purposes

- 1) It with stands soil pressure when driven in soft ground.
- 2) It supports the loosed rock pieces during blasting.
- 3) It gives proper section to tunnel.
- 4) It strengthens the weak locations in the tunnel.
- 5) It Supports loosed pieces of rock which might have become loosen during blasting.
- 6) It protects rock susceptible to air slaking.
- 7) It ensures stream line flow for water tunnel.
- 8) It makes inside of tunnel free from water percolation.

02

02  
(any  
four)

e) Explain suspension bridges with a neat sketch.

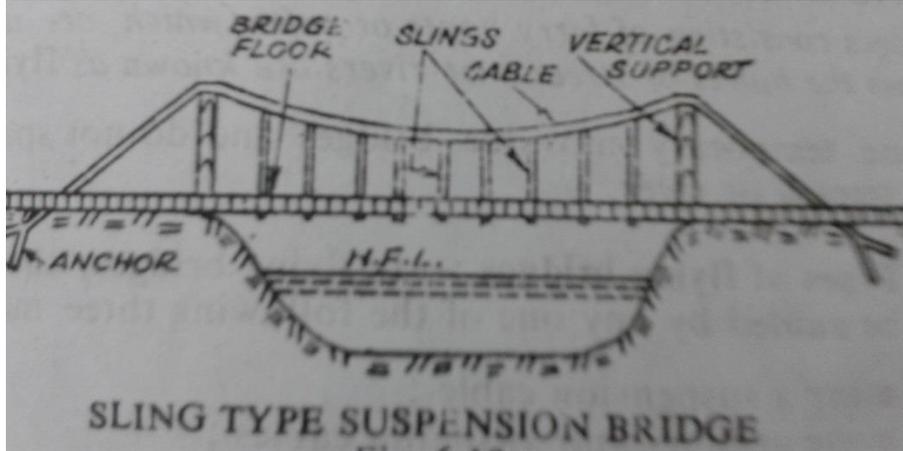
**Suspension bridges :-**

The bridges consisting of two or more cables hanging in a curve, which supports the roadways are known as suspension bridges .

They are used where it is difficult to adopt other type of bridges they are economically used for every large span. There are various types of suspension bridges. These are single span bridges there are two main cables on each side of

02

roadways. They are carried over solid piers and are securely anchored to the banks. The road way is suspended from two main cables by means of suspenders. Sometime two sides span are added besides the main central span. The side span rest either over a separate supported system or suspended from the back stays. Suspension bridges are not rigid the dip is usually taken as  $1/10$  th of span



02

**f) State the factors affecting the alignment of tunnel.**

1. Tunnel should pass through hard rock because the tunnelling progresses in hard rock is more than soft rock and the chances of accidents are much less. 01
2. There should be no water channel near the alignment. 01
3. The alignment should be such that tunnel may pass beneath the high ridges so as to avoid easy percolation of water from the nearby channel 01
4. The portal of the tunnel should be near the dumping yard so that excavated material may be removed in less time. 01

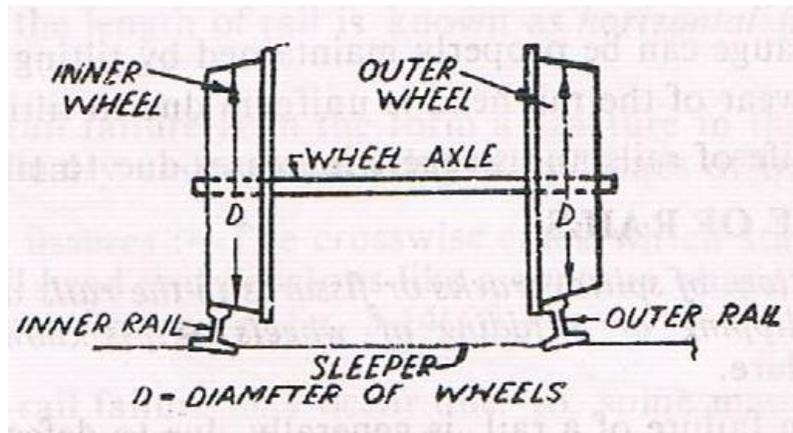
**Q.3) Attempt any Two of the following:**

16

**a) Define coning of wheels. Explain with a neat sketch the behavior of coned wheel on curved path.**

**Definition:-**

The art of providing an outward slope of 1 in 20 to the treads of wheels of rolling stock is known as coning of wheels.



(Note : 02 marks definition , labelled sketch 04 marks)

**Behavior of coned wheel on curved track –**

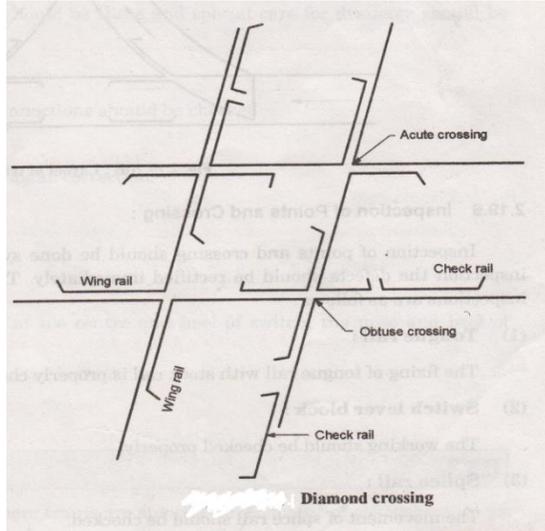
On curves, the outer wheels of a train have to travel greater distance than the inner

02

wheels. Under the effect of centrifugal force, the axle moves towards the outer rail. Due to coning of wheels, the diameter of wheels on outer rails increases, while on inner rails it decreases as shown in figure. This helps the outer wheels to cover greater distance than inner wheels without any slip.

**b) Draw and explain diamond crossing? State its components.**

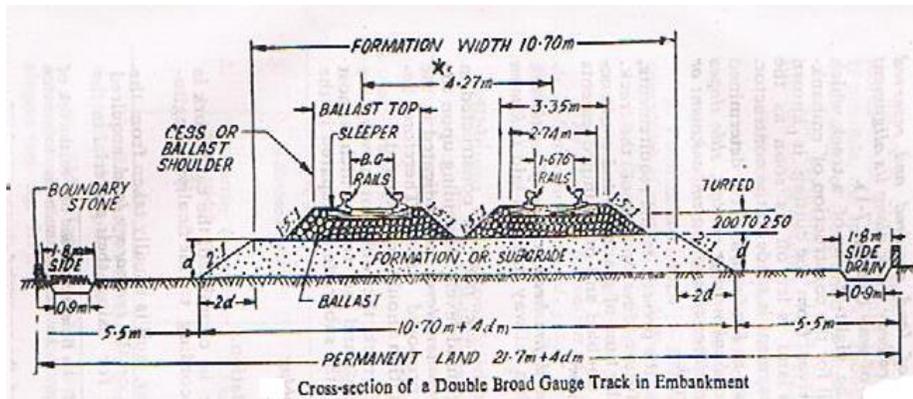
**Diamond crossing** The crossing which is formed when one track crosses another track at an obtuse angle is called as obtuse angle crossing or diamond crossing. This type of crossing consists of two acute angle and two obtuse angle crossing.



Components of Diamond crossing:- 1) Two acute angle crossing 2) Two obtuse angle crossing 3) Tongue rail 4) Check rail 5) Wing rail  
 (Note 02 marks for explanation, 04 marks sketch, 02 marks components)

**c) Draw a Cross section of a board gauge double line railway track and name its component.**

Cross section of broad gauge double line of railway track in embankment.



(Note:-Sketch 04 marks , 04 marks labelling)

**Q.4) Attempt any Two of the following**

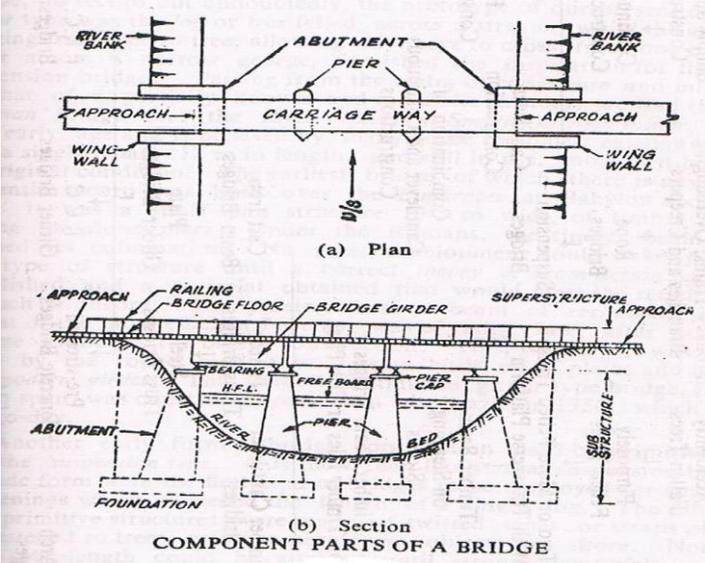
a) Draw a neat sketch of a bridge and show and label all the component parts. Classify the bridges according to alignment and position of HFL.

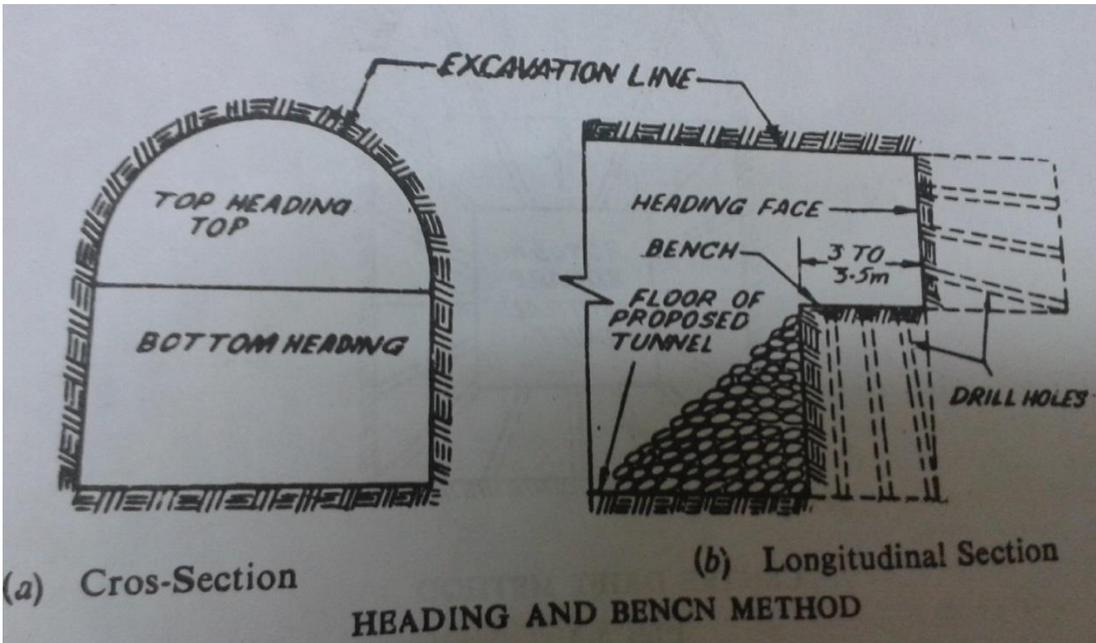
**Ans:-**

Classification of bridges according to alignment -

16

01

<p>i) Straight bridges    ii) Skew bridges                  Classification of bridges according to positions of HFL-                  i) Submersible bridges    ii) Non submersible bridges</p> <p><b>Sketch of bridge showing all components</b></p> 	<p>01</p> <p>04 for sketch</p> <p>02 for labelling</p>
<p><b>b) Define</b>                  i) Afflux    II) effective span    III) Economic span    IV) Curtain wall                  V) Clear span    VI) Free board    VII) Water way    VIII) Scour depth</p>	
<p>i) <b>Afflux</b> – The heading up of the water above its normal level while passing under the bridge is called afflux.</p>	<p>01</p>
<p>ii) <b>Effective span</b> – The centre to centre distance between any two adjacent supports (abutment and pier or between two piers ) of bridge superstructure is called effective span.</p>	<p>01</p>
<p>iii) <b>Economic span</b> – the span for which the total cost of bridge is minimum is known as economic span</p>	<p>01</p>
<p>iv) <b>Curtain wall</b> – Curtain walls are provided in causeways to guard against scour and to prevent the causeways slab or foundation from undermining. Curtain walls are constructed both on U/S and D/S side.</p>	<p>01</p>
<p>v) <b>Clear span</b>- The clear distance between any two adjacent supports of bridge superstructure is called clear span.</p>	<p>01</p>
<p>vi) <b>Free board</b> – The difference between the highest flood level after allowing the afflux, if any and lowest point on the underside of bridge superstructure is called free board.</p>	<p>01</p>
<p>vii) <b>Water way</b>- The sectional area at the site of bridge through which water flows is termed as waterway.</p>	<p>01</p>
<p>viii) <b>Scour depth</b> – The normal scour depth is the depth of water in the middle of stream when it is carrying maximum flood discharge.</p>	<p>01</p>
<p><b>c) Describe heading and bench method of tunneling in hard rock with neat sketch.</b></p>	
<p><b>Heading and bench method of tunneling</b> In this method, the driving of tunnel is done in two portions of its section. The driving of top portion is done in advance of the bottom portion</p>	

<p>After driving the top portion 3 to 3.5m , holes are driven into the head &amp; bench. Then these holes are loaded together with explosives together for blasting. Firing of these bench holes is just done before the heading holes are fired. After this mucking is done manually.</p> <p>This method is suitable for large tunnels &amp; where quality of rock is not very satisfactory.</p>  <p>The diagram consists of two parts: (a) Cross-Section and (b) Longitudinal Section. Part (a) shows a semi-circular top heading above a rectangular bottom heading. Part (b) shows a 3D perspective of the heading face, bench, and floor of the proposed tunnel, with drill holes shown as vertical lines. Labels include 'EXCAVATION LINE', 'TOP HEADING TOP', 'BOTTOM HEADING', 'HEADING FACE', 'BENCH', 'FLOOR OF PROPOSED TUNNEL', 'DRILL HOLES', and '3 TO 3.5m'.</p>	<p>04 Marks</p> <p>04 labelled sketch</p>
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**Q.5) Attempt any Two of the following** **16**

**a) Classify tunnels according to:**  
**i) Traffic ii) Conveyance iii) Type of Material iv) Position of alignment**

**Tunnels are classified according to:**

- i) **Traffic:-** Traffic Tunnels: Traffic tunnels are classified as :
  - 1. Railway Tunnels      2. Highway Tunnels      3. Navigation Tunnels
  - 4. Subway Tunnels      5. Pedestrian Tunnels

(ii) **Conveyance tunnel**

- 1. Water supply tunnel      2. Hydropower Tunnels
- 3. Sewage Tunnels      4. Tunnels for Industrial Use.
- 5. Tunnels for Intake and Conveying Public Utilities

iii) **Classification of tunnel according to the type of materials**  
 (Types of Soil through which they are driven).

- 1. Tunnels in Hard Rock      2. Tunnels in Soft Rock
- 3. Tunnels in Quick Sand      4. Tunnels under River Bed (Submarine Tunnels)
- 5. Open-Cut Tunnels.

(iv) **Classification of tunnels according to position of alignment.**

- 1. Saddle and Base Tunnels      2. Spiral Tunnels
- 3. Off-Spur Tunnels      4. Slope Tunnels.

**b) State the different methods of tunneling in soft rock and explain any one method with a neat sketch.**

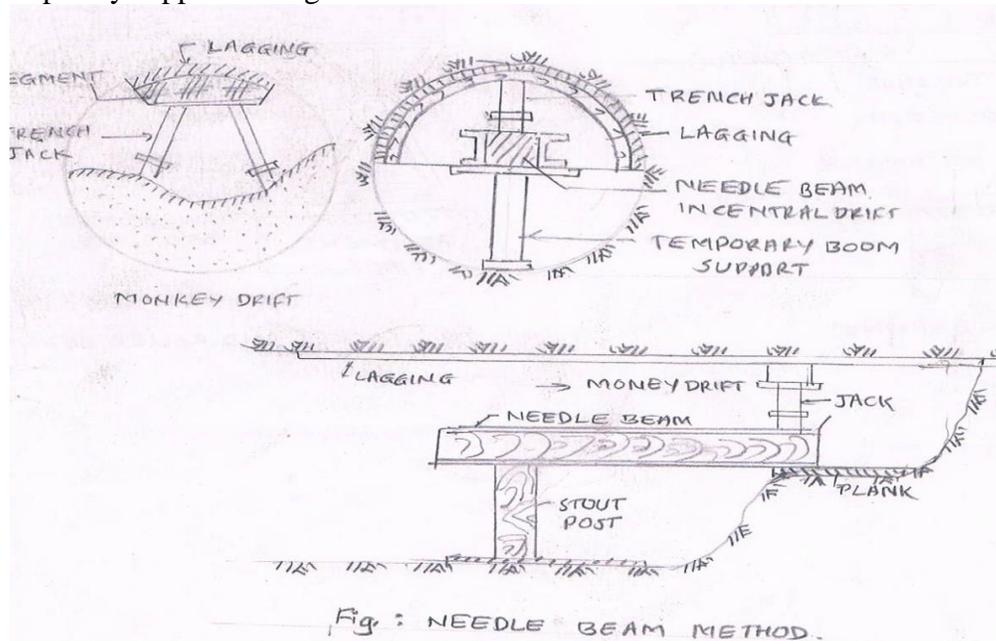
Following methods can be adopted for tunnelling in soft soil.(any six)

1. Needle Beam Method.	2. Forepoling Method.	03marks
3. Linear Plate Method.	4. Shield Method.	

5. American Method.
7. Belgian method
9. Italian method.

6. English Method.
8. Austrian method
10. Army method.

1. **Needle Beam Method:-** In this method a 5 to 6 m long stout timber beam or a composite flitched beam, known as needle beam, is used which forms the main temporary support during the excavation.



02  
for  
sketch

03  
for  
explanation

### Construction procedure:

- Step i): Make the monkey type drift of about 1m size is made on the working face of the proposed tunnel .
- ii). The roof of this drift is then supported on lagging provided on wooden segments which carried on the trench jacks as shown in figure.
- iii) After this, needle beam is placed with its front end, resting horizontally on planks, which are placed on the floor of the monkey drift.
- iv) The rear end of the needle is then supported on stout vertical posts resting on planks, placed on the floor of the proposed tunnel as shown in figure.
- v) After this, a trench jack is placed symmetrically on the needle beam to support the wooden segment already provided to transfer the roof load to the needle beam.
- vi) The other trench jacks are then removed and drift is widened sideways in parts, supported by laggings, segments and trench jacks resting on the sides of the needle beam as shown in fig.
- vii) When full section of the proposed tunnel is excavated, all the segments support the roof load due to arch action and thus the trench jacks can be removed.
- viii) For further advancing the tunnel, a new drift is made and this procedure is repeated to complete the whole tunnel.

OR

2. **Fore poling Method:-** In olden days this method was very common, but it has been replaced by compressed air method. Very skilled labour are required for doing tunneling in soft ground by this method.

**Construction procedure:**

- Step i.) At the designed location on the surface, the shaft is sunk from the ground surface to the grade level and the timber sheeting is provided to prevent the soil from collapsing.
- ii) Wooden bent is set up few cm from the sheeting and securely braced as shown in figure.
- iii) Now the holes are drilled in the timber sheeting above and below the cap as shown in figure.
- iv) The sheeting above the cap is cut out along the top lines of the holes.
- v) Now the wedge end shaped Fore-poles having size about 170x15x5 cm are driven through the cut in the sheets, into the ground at an inclination up to their half-length as shown in fig.
- vi) A timber plank is placed along the roof and wedges are placed to press the hanging sides of the fore poles from top as shown in fig.
- vii) The face sheeting is broken along the lower line of holes below the cap and the excavation is started below the fore poles.
- viii) Now horse head is placed about 60cm from the sheeting resting on the small foot block as shown in fig. Spikes are then driven to full length.
- ix) The excavation is done further into the shaft because the ends of the spikes are unsupported. A breast board is provided 45 cm ahead as shown in fig.
- x) Now the next cap is provided 1.2 m ahead, and is held in position temporarily by a single post set on the bench as shown in fig.
- xi) The side spikes are driven to their full length.
- xii) A pair of needle beam( boom) is provided to support the lower cap and the excavation in the lower portion is done.
- xiii) While providing the booms the breasting board are removed by one while doing the excavation. The breast boards are immediately reset one at a time at the front end.
- xiv) Immediately after excavating the portion of the tunnel to the grade, the legs and foot blocks are set and the load from the boom is transferred to the legs and foot blocks, and the booms are taken out.
- xv) Now the work of the tunneling is started again in the same sequences as given above steps.

This method is good method for the construction of small tunnels for sewers, pipelines etc. or ordinary method. This method is tedious, requires skilled labour and too much time for tunneling.

**OR**

3. **Linear Plate Method:**-In this method pressed steel linear plates are used to support the soil during excavation work. The standard size of the plate is 91cm x 41cm .all the four side of these plates are flanged 5 cm with holes for bolting with each other.

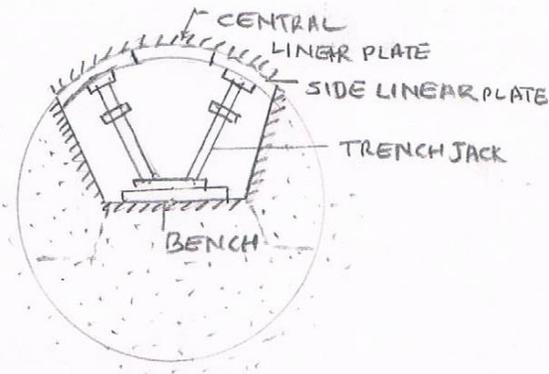
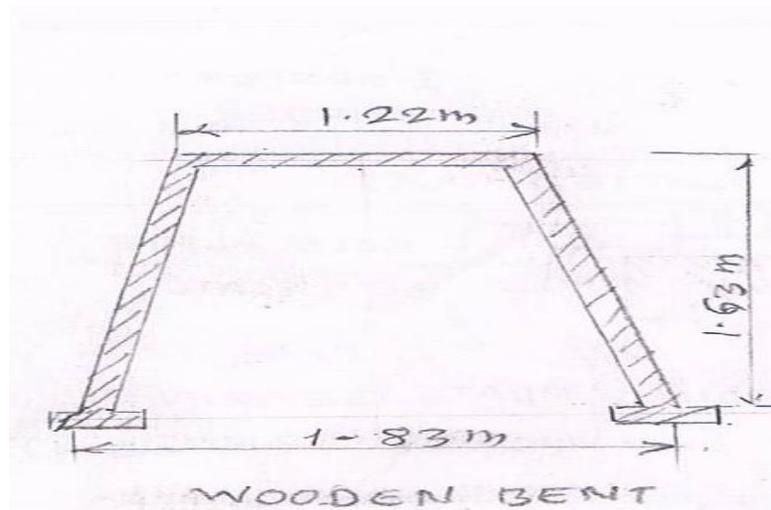


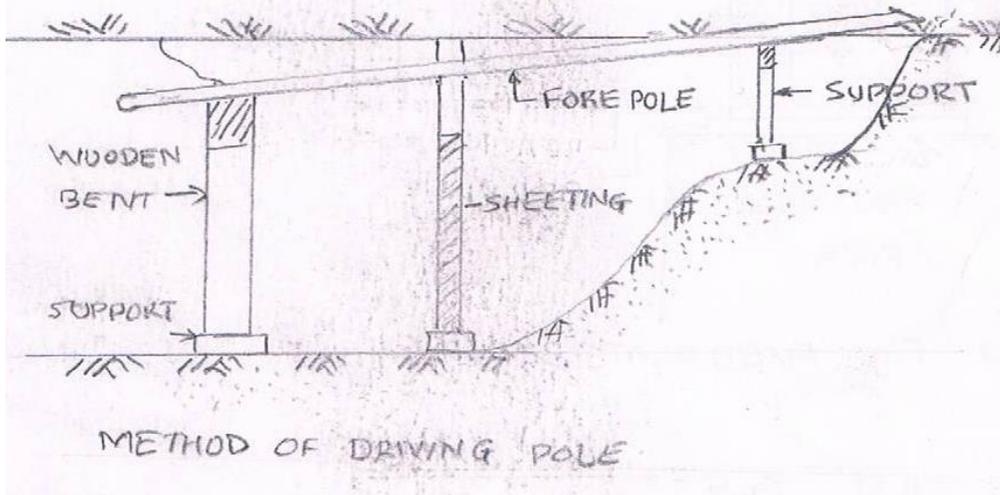
Fig. : LINEAR PLATE METHOD.

**Construction procedure:**

- i) About 40 cm deep hole is excavated at the crown and a linear plate is placed in position to support the roof.
- ii) Now the excavation is done on the sides and linear plates are provided and bolted with central plate.
- iii) The excavation is done in the lower side and the trench jacks are provided to supports the linear plates as shown in fig.
- iv) After further excavation wall plates and wedges are provided at the ends of the lower liner plate and the load of the jacks is transferred to them. Now the trench jacks are removed and the excavation is started further as above.

Following are the advantages to the liner plate method.- The excavation can be done quickly and economically .These are lighter in weight and easy to handle than timber planks and struts. They requires less number of joints. They are more fire-resistive than timber. If the lining of R.C.C. is to be done , the plates can be embedded in the concrete and the cost of the reinforcement can be reduced.

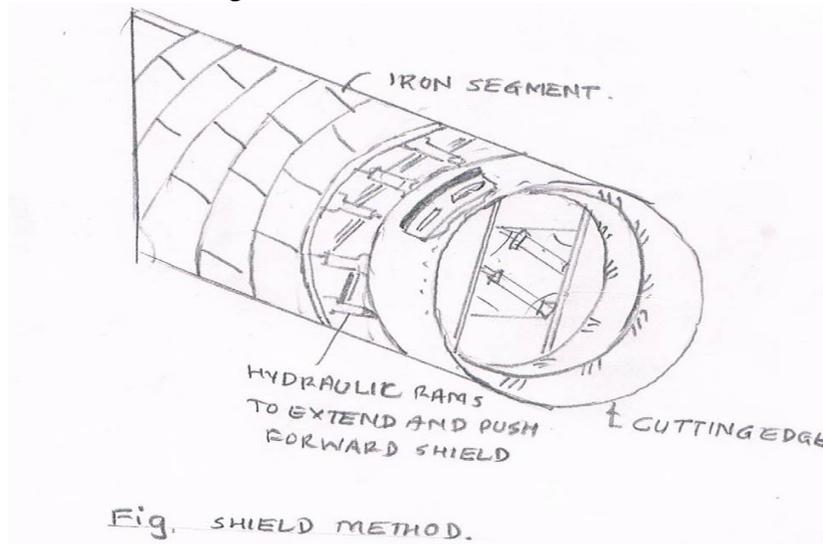




OR

#### 4. Shield Method:-

Now a days tunneling in soil is done with the helps of a mechanical device known as shield. Shields as shown in fig bellow are used for the construction of circular tunnels.



Shield consists of

- i) Skin or outer shell: It is constructed with steel plates, by riveting or welding them together.
- ii) Cutting edge: It is used to cut the soft material.
- iii) Hydraulic rams: It is used to extend and push the shield forward with the help of these hydraulic rams the cutting edge is pushed forward to cut the material.
- iv) Tail: It is the end portion of the shield, at this place lining is done so that roof tunnel may not collapse.

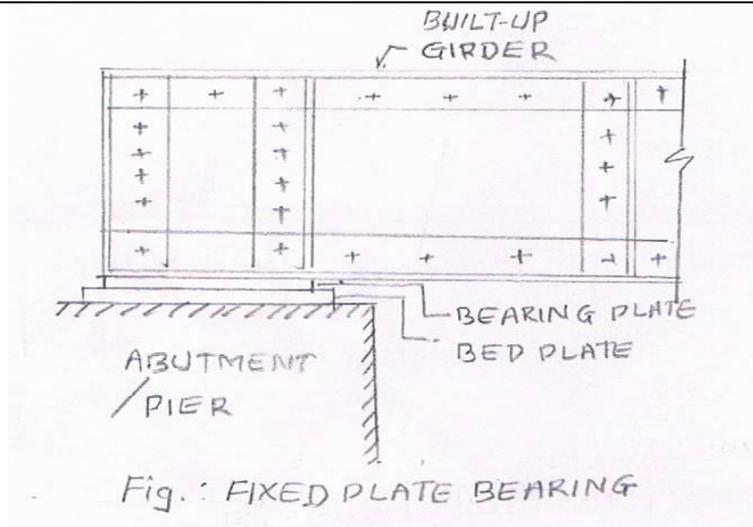
Inter structure consist of ting girders braced together to take all types of stresses

**c) Draw sketches of the following types of bearing and explain the condition where each is used.**

**i) Fixed plate bearing ii) Slide plate bearing iii) Rocker bearing iv) Roller bearing**

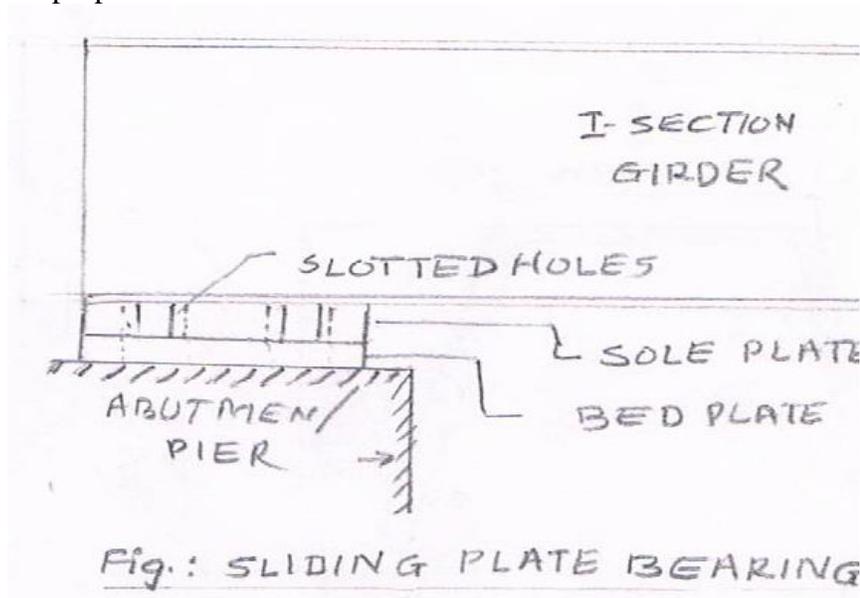
- i) **Fixed plate bearing:** To hold the one end of the girder as it does not permit any longitudinal movement of the girders. It is recommended up to span of 20m

01



01

ii) **Slide plate bearing:** The end of the girder where it is required to allow longitudinal movement of the girder, as slotted types of holes are provided in the sole plate for this purpose.

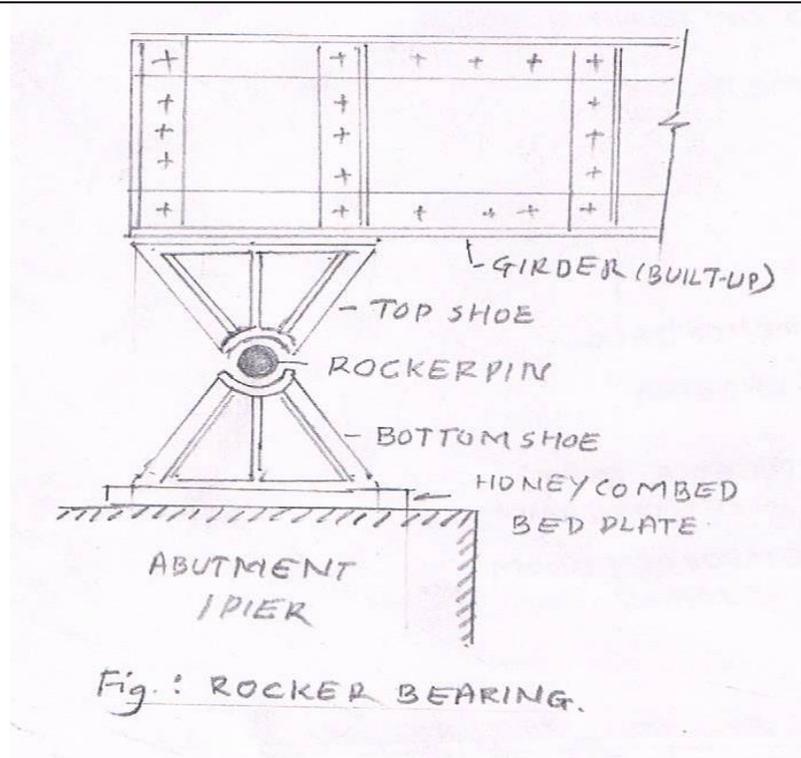


01

01

iii) **Rocker bearing:** For span more than 25m and when bridge subject to more chances of deflection.

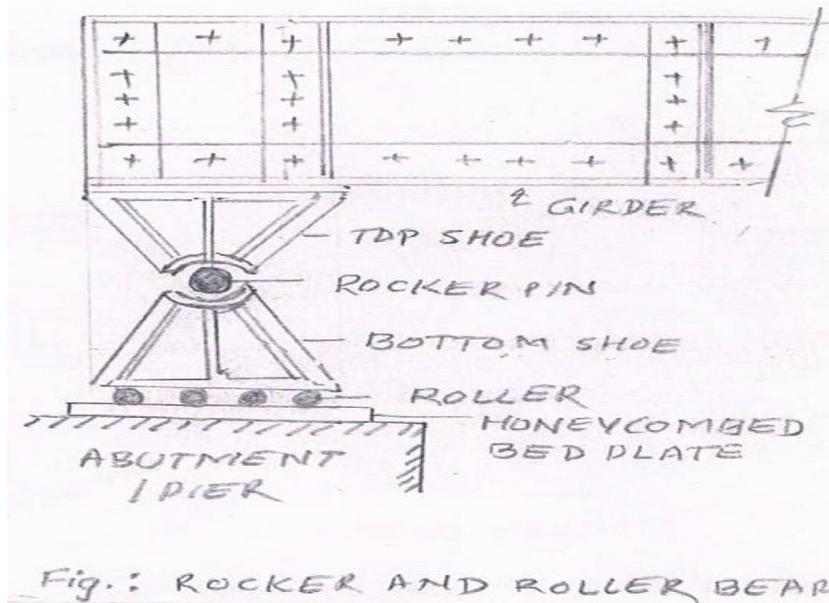
01



01

01

iv) **Roller bearing:** when it required to provide longitudinal movement of the bridge girder, which is achieved by cylindrical rollers provided at the bottom shoe, are free to roll on bottom steel plate.



Q.6) Attempt any FOUR of the following

16

a) State the requirements of an ideal sleeper.

**The requirements of an ideal sleeper are :**

- i) The sleepers should be economical in their initial as well as maintenance cost.
- ii) The sleepers should have long life.

<p>iii) The sleepers should be able to maintain correct gauge.  iv) The sleepers should be quite durable ( i.e. They should offer sufficient resistance to weathering agencies.  v) The sleepers should be suitable to each type of ballast.  vi) The sleepers should suitable for track circuiting.  vii) The sleepers should have such fittings that they can easily be removed, replaced, lifted and packed when required.  viii) The sleepers should have sufficient (moderate)weight for their stability.( and should not be too heavy or excessively light)  ix) The sleepers should be sufficiently strong to take bending stress under the moving wheel loads.  x) The sleepers should be of such design that the gauge, alignment of track and levels of rails can be easily adjusted and maintained.  xi) The sleepers should provide sufficient bearing area below the rail seat over the ballast.  xii) The sleepers should be of such a design as to facilitate easy removable and replacement of ballast.</p>	<p>½ mark each (any eight)</p>
<p><b>b) State the functions of Rails</b></p>	
<p>The functions of Rails are i) To provide a hard, strong surface for movement of trains.  ii) To provide smooth surface for movement of trains with minimum tractive resistance.  iii) To bear the stresses developed in the track due to heavy wheel loads, lateral and braking forces and also due to variation of temperature  iv)To transmit the axle loads of the trains to sleepers.  v)To reduce the pressure on ballast and formation</p>	<p>01 mark each ( any four)</p>
<p><b>b) What do you mean by a causeway? State types of causeways.</b></p>	
<p><b>Cause ways:</b> The temporary bridges constructed with their floor flush or little above the bed of the stream which allow the high flood discharge to pass always over their floor carrying the communication route are known as causeways,(also known as Irish bridges or metal dip).  <b>Types of causeways are:</b>  i)Flush causeways (or metal dip)  ii)Low level causeways.( or Irish bridges)  iii) High level causeways(Vented causeways)</p>	<p>02  02</p>
<p><b>d) What are the precautions to be taken while construction of tunnel ?</b></p>	
<p>The precautions to be taken while construction of tunnel are: ( any four)  i) The shape of the tunnel should be decided according to its purpose.  ii)Cross sectional dimensions of the tunnel should be decided to achieve economy in its construction.  iii) Economic calculations for extent of equipment and labour should be made before starting the tunnel construction.  iv) Pattern of blasting the material in different locations should be decided for maintaining speed of driving and safety.  v)The sequence of operation must be decided so that proper use of labour and equipment is made.  vi)Labour should be well organized to maintain continuous progress of the tunneling operations.  vii)The use of out dated or unsuitable tools should be avoided.</p>	<p>01 mark each ( any four)</p>

