



Subject: Transportation Engineering

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 the candidate and those in the 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 the model answer.
- 6) In case of some questions credit may be given by judgment 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.

**Model Answer**

| Que. No. | Sub. Que. | Model Answers   | Marks                        | Total Marks |
|----------|-----------|---|------------------------------|-------------|
| Q.1      | a)        | <b>Attempt any <u>SIX</u> of the following:</b>   |                              | <b>12</b>   |
|          | (i)       | <b>Enlist necessity of cross drainage work for roads.</b><br><b>Ans.</b><br>1. Excess Moisture content causes reduction in bearing strength of base course bed materials.<br>2. Excess moisture content in layers of road way causes permanent failure.<br>3. Due to poor drainage, waves and corrugations are formed in flexible pavements.<br>4. At places where temperature often reaches to freezing point frost action of water entering the pavements structure may cause the damage. | <b>1 mark each (Any two)</b> | <b>2</b>    |
|          | (ii)      | <b>State the factors affecting choice of transport.</b><br><b>Ans.</b><br>The choice of transportation depend upon the following factors;<br>1. The length of haul<br>2. Weight and size of consignment<br>3. Traffic density<br>4. Nature of route<br>5. Quality of service  | <b>1 mark each (Any two)</b> | <b>2</b>    |



| Que. No. | Sub. Que. | Model Answers   | Marks                              | Total Marks |
|----------|-----------|---|------------------------------------|-------------|
| Q.1      | a)        |   |                                    |             |
|          | (iii)     | <b>State any two characteristics of transport by railways.</b><br><b>Ans.</b><br>1. Suitable for transportation of bulky cargo over long distance.<br>2. Power required for railways is comparatively less because of the less inactive resistance of steel wheel on steel rails.<br>3. It connects remote cities and villages.<br>4. Longer distance is covered in less amount of money compared to airways and roadways.<br>5. In times of war, railways help in transporting arms and ammunition from one place to another place.<br>6. During famines and calamities, railway help in providing medical aid and other help to those affected by it. | <b>1 mark each (Any two)</b>       | <b>2</b>    |
|          | (iv)      | <b>Define Cant deficiency.</b><br><b>Ans.</b> <u>Cant Deficiency</u> : The difference between equilibrium cant necessary for maximum permissible speed on curved track and the actual cant provided is known as cant deficiency.  | <b>2 marks</b>                     | <b>2</b>    |
|          | (v)       | <b>State different types of railway stations.</b><br><b>Ans.</b><br>Different types of railway stations are;<br>1. Way Side Station<br>a. Halt Station<br>b. Flat Station<br>c. Crossing Station<br>2. Junction Station<br>3. Terminal Station  | <b>1 mark each (Any two)</b>       | <b>2</b>    |
|          | (vi)      | <b>Define afflux and scour.</b><br><b>Ans.</b><br><u>Afflux</u> : It is the rise in water surface of water – course, caused due to the obstruction by the bridge in the flow of water. The heading up of the water above its normal level while passing under the bridge is called afflux.<br><br><u>Scour</u> : The process of cutting or deepening of river bed due to action of water is called scouring.  | <b>1 mark</b><br><br><b>1 mark</b> | <b>2</b>    |



| Que. No. | Sub. Que.   | Model Answers   | Marks                        | Total Marks |
|----------|-------------|---|------------------------------|-------------|
| Q.1      | a)<br>(vii) | <b>State the suitability of well foundation used for bridges.</b><br><b>Ans.</b><br>1. Well foundation is suitable where the soil stratum comprises of sand or stiff clay.<br>2. It is suitable in under water construction   | <b>1 mark each</b>           | <b>2</b>    |
|          | (viii)      | <b>State any two purposes for providing tunnels.</b><br><b>Ans.</b><br>The following are the purposes of providing tunnels;<br>1. Tunnel connects the two terminal stations of shortest roots.<br>2. They facilitate less route length and thus results in less transportation cost.<br>3. They carry railway lines, roads and public utilities like water, oil, gas etc. across a stream or mountain.<br>4. Tunnel provides free movement of traffic throughout the year even during snow fall and landslide.<br>5. Tunnel facilities conduction of water to generate the power.<br>6. Tunnel helps in avoiding acquisition of costly land and property for railway or road projects.<br>7. They eliminate excessive cost of maintenance of an open cut subjected to land slide. | <b>1 mark each (Any two)</b> | <b>2</b>    |

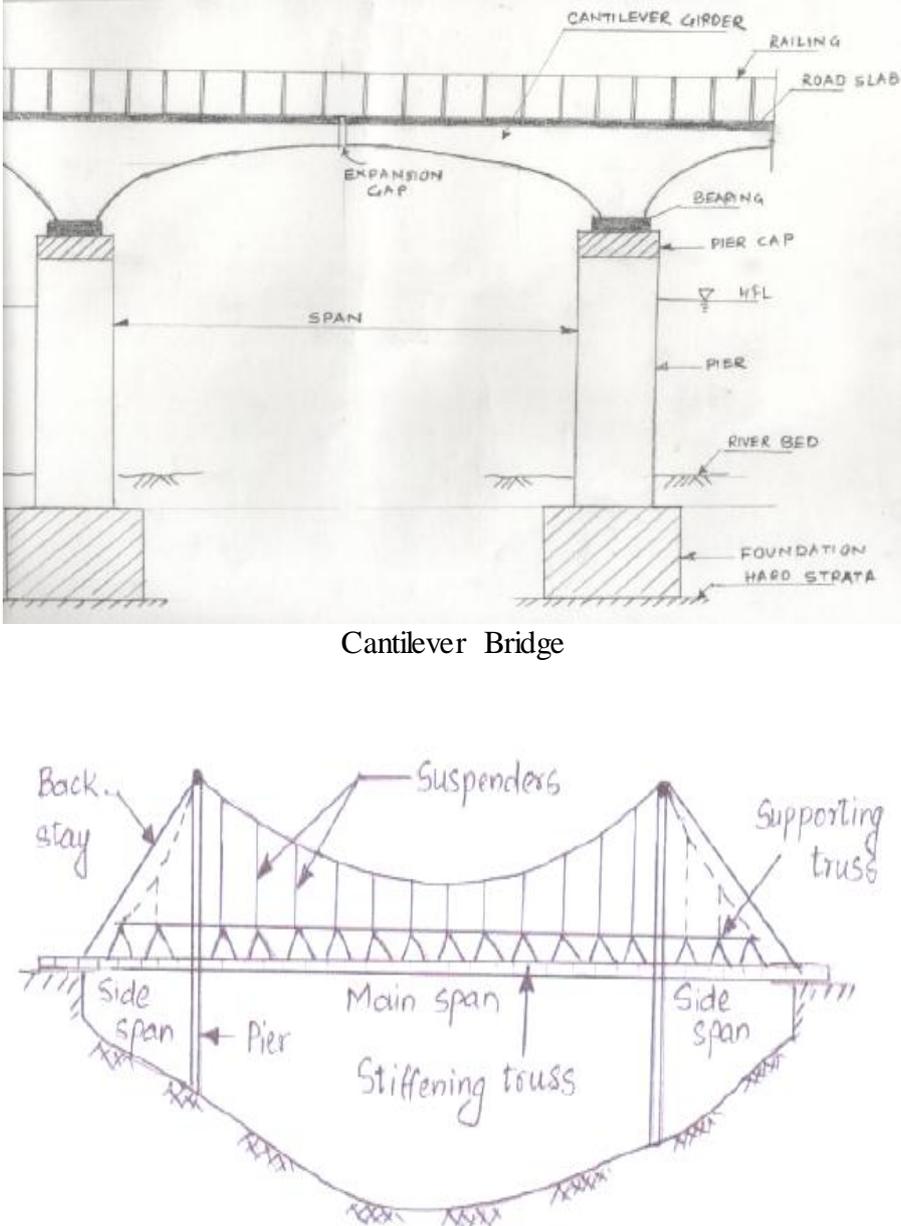


| Que. No. | Sub. Que. | Model Answers  | Marks                         | Total Marks |
|----------|-----------|--|-------------------------------|-------------|
| Q.1      | b)        | <b>Attempt any <u>TWO</u> of the following:</b>  |                               | <b>8</b>    |
|          | (i)       | <b>What are the basic requirements for good alignment for railway track?</b><br><b>Ans.</b><br>Factors governing the rail alignment are as follows;<br>1. <b><u>Obligatory Points</u></b> : Alignment of track has to be deviated from straight line because it has to pass through obligatory points like market places, educational centers, etc. Certain undesirable locations have to be avoided, for e.g. Low lying areas, marshy places, areas requiring deep cutting, etc.<br>2. <b><u>Traffic</u></b> : The alignment should suit the traffic growth and its impact should be studied carefully and the alignment should pass the thickly populated areas.<br>3. <b><u>Geometric Designs</u></b> : The gradient must not exceed the permissible limits and the curves from economical point of view should be of maximum possible radii.<br>4. <b><u>Topography of Area</u></b> : According to topography, the alignment of a track may be classified as:<br>i. Valley Alignment: 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.<br>ii. Cross Country Alignment: 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. Thus, the routes in cross country have sags and summit in succession.<br>iii. Mountain Alignment: The main object in railway alignment is to keep the track as straight as possible. In mountainous region it is achieved by increasing the length of the track keeping the gradient up to the limit of ruling gradient.<br>5. <b><u>Economic Consideration</u></b> : The alignment should also be economical. The initial cost, cost of maintenance and vehicle operation cost should be taken into consideration.<br>6. <b><u>Other consideration</u></b> : From drainage point of view, marshy tracks should be avoided. The alignment should be such that the excessive cutting of the rock is avoided. Cutting in snowfall areas should be avoided as it will create problem of cleaning the track in cold season. | <b>1 mark each (Any four)</b> | <b>4</b>    |



| Que. No. | Sub. Que.  | Model Answers  | Marks   | Total Marks     |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |
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| Q.1      | b)<br>(ii)   | <p><b>Explain important points to be noted in connection with bridge approaches.</b></p> <p><b>Ans.</b></p> <ol style="list-style-type: none"> <li>Approaches should be usually provided at both ends of the bridge.</li> <li>As per IRC specifications, the approaches should have a minimum straight length of 15 m on either side of bridge.</li> <li>The approaches should be in line with the longitudinal centre line of the bridge.</li> <li>In no case the approaches should be curved at the entrance and exit of the bridge structure.</li> <li>Approaches should be provided with retaining wall and abutment pier on either side.</li> <li>If approaches run over extended portions of the main bridge, approach pier should be provided.</li> </ol>   | <p><b>1 mark each (Any four)</b></p>  | <p><b>4</b></p> |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |
|          | (iii)  | <p><b>Differentiate between cantilever and suspension bridge.</b></p> <p><b>Ans.</b></p> <table border="1"> <thead> <tr> <th></th> <th>Cantilever Bridge</th> <th></th> <th>Suspension bridge</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>A bridge in which each span is constructed from cantilevers built out sideways from piers is known as cantilever bridge.</td> <td>1</td> <td>The bridge having its superstructure consisting of one or two set of cables which carry the bridge floor by means of suspenders is known as suspension bridge</td> </tr> <tr> <td>2</td> <td>Spans up to 600 m.</td> <td>2</td> <td>Spans from 600 – 1200 m.</td> </tr> <tr> <td>3</td> <td>Comparatively heavier than suspension bridge.</td> <td>3</td> <td>They are light weight.</td> </tr> <tr> <td>4</td> <td>No ease in transportation of materials.</td> <td>4</td> <td>The material of construction can be transported easily.</td> </tr> <tr> <td>5</td> <td>The time of construction is more than suspension bridge.</td> <td>5</td> <td>The time of construction is less comparatively.</td> </tr> <tr> <td>6</td> <td>Aesthetic appearance not as good as suspension bridge.</td> <td>6</td> <td>They give good aesthetic appearance.</td> </tr> <tr> <td>7</td> <td>Construction can be done easily with the help of available machinery.</td> <td>7</td> <td>There are very few suppliers of bridge cables and machined sockets.</td> </tr> <tr> <td>8</td> <td>The superstructure cost less than suspension bridge.</td> <td>8</td> <td>The superstructure cost proves to be higher than other type of spans.</td> </tr> <tr> <td>9</td> <td>Figure of Cantilever Bridge</td> <td>9</td> <td>Figure of Suspension Bridge</td> </tr> </tbody> </table> |   |                 |  | Cantilever Bridge |  | Suspension bridge | 1 | A bridge in which each span is constructed from cantilevers built out sideways from piers is known as cantilever bridge. | 1 | The bridge having its superstructure consisting of one or two set of cables which carry the bridge floor by means of suspenders is known as suspension bridge | 2 | Spans up to 600 m. | 2 | Spans from 600 – 1200 m. | 3 | Comparatively heavier than suspension bridge. | 3 | They are light weight. | 4 | No ease in transportation of materials. | 4 | The material of construction can be transported easily. | 5 | The time of construction is more than suspension bridge. | 5 | The time of construction is less comparatively. | 6 | Aesthetic appearance not as good as suspension bridge. | 6 | They give good aesthetic appearance. | 7 | Construction can be done easily with the help of available machinery. | 7 | There are very few suppliers of bridge cables and machined sockets. | 8 | The superstructure cost less than suspension bridge. | 8 | The superstructure cost proves to be higher than other type of spans. | 9 | Figure of Cantilever Bridge | 9 |
|          | Cantilever Bridge  |  | Suspension bridge   |                 |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |
| 1        | A bridge in which each span is constructed from cantilevers built out sideways from piers is known as cantilever bridge. | 1  | The bridge having its superstructure consisting of one or two set of cables which carry the bridge floor by means of suspenders is known as suspension bridge |                 |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |
| 2        | Spans up to 600 m.   | 2  | Spans from 600 – 1200 m.  |                 |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |
| 3        | Comparatively heavier than suspension bridge.  | 3  | They are light weight.  |                 |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |
| 4        | No ease in transportation of materials.  | 4  | The material of construction can be transported easily.   |                 |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |
| 5        | The time of construction is more than suspension bridge.   | 5  | The time of construction is less comparatively.   |                 |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |
| 6        | Aesthetic appearance not as good as suspension bridge.   | 6  | They give good aesthetic appearance.  |                 |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |
| 7        | Construction can be done easily with the help of available machinery.  | 7  | There are very few suppliers of bridge cables and machined sockets.   |                 |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |
| 8        | The superstructure cost less than suspension bridge.   | 8  | The superstructure cost proves to be higher than other type of spans.   |                 |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |
| 9        | Figure of Cantilever Bridge  | 9  | Figure of Suspension Bridge   |                 |  |                   |  |                   |   |  |   |   |   |                    |   |                          |   |   |   |                        |   |   |   |   |   |  |   |   |   |  |   |                                      |   |   |   |   |   |  |   |   |   |                             |   |



| Que. No. | Sub. Que.   | Model Answers   | Marks | Total Marks |
|----------|-------------|---|-------|-------------|
| Q.1      | b)<br>(iii) |  <p>The diagram shows two types of bridges. The top diagram is a Cantilever Bridge, which features a central span supported by two piers. The bridge deck is supported by cantilever girders that extend over the piers. Labels include: CANTILEVER GIRDER, RAILING, ROAD SLAB, EXPANSION GAP, BEARING, PIER CAP, HFL (High Flood Level), PIER, RIVER BED, and FOUNDATION HARD STRATA. The bottom diagram is a Suspension Bridge, which has a main span supported by two towers and two side spans. Labels include: Back stay, Suspenders, Supporting truss, Side span, Pier, Main span, and Stiffening truss.</p> |       |             |



| Que. No. | Sub. Que. | Model Answers  | Marks                         | Total Marks |
|----------|-----------|--|-------------------------------|-------------|
| Q.2      |           | <b>Attempt any <u>FOUR</u> of the following:</b>   |                               | <b>16</b>   |
|          | a)        | <b>Explain different gauges of railway track and define negative cant.</b><br><b>Ans.</b><br><b><u>Different types of gauges of railway track:</u></b><br>Broad Gauge (1676 mm)<br>Meter Gauge (1000 mm)<br>Narrow Gauge ( 762 mm or 610 mm)<br><br><b><u>Negative Cant:</u></b><br>On the curve where main track and branch track meets then the stage occurs such that the outer rail is below the inner rail, then it is called as negative cant or negative super elevation.   | <b>2 mark</b>                 | <b>4</b>    |
|          | b)        | <b>State the necessity of railway track maintenance.</b><br><b>Ans.</b><br>The necessity of railway track maintenance arises due to following reasons;<br>1. The strength of track structure goes on reducing high speed of trains, heavy excel loads and repletion of loads. The elastic structure of railway track thus gets distributed in alignment, gauge and surface level of rails.<br>2. The track structure is subjected to deteriorating effects like rain water, action of sun and wind. The wear and tear of rails and of rolling stock is then bound to take place.<br>3. The track structure has to bear many other curvature speeds and load effects. Particularly on curves, points and crossings bridge approaches and level crossings.<br>4. It is therefore essential to maintain the track in good condition so that the train may run over it safely at specified speeds.<br>5. If the track is not properly maintained then it may also result in extreme cases of derailments of trains with possible loss of lives and property. | <b>1 mark each (Any four)</b> | <b>4</b>    |

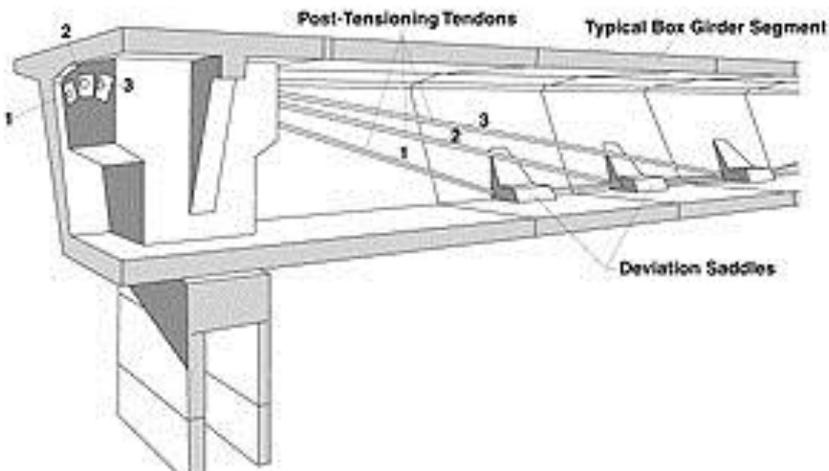


| Que. No. | Sub. Que. | Model Answers  | Marks   | Total Marks |
|----------|-----------|--|---|-------------|
| Q.2      | c)        | <p><b>State any four characteristics of Permanent Way Inspector.</b></p> <p><b>Ans.</b></p> <ol style="list-style-type: none"><li>1. The Permanent Way Inspector is personally responsible for maintaining the track in good condition for the passage of trains. For this purpose, he travels over the track by push trolley and watches the defects of the track and arranges the repair of the defective track by his gang.</li><li>2. He is responsible to carry out the renewals of rails and sleepers.</li><li>3. He should maintain the record of wear and tear of rails in his section. He should chalk out programme for lubrication of rail joints in such a way that all the rail joints are lubricated on a year during winter season.</li><li>4. He is responsible to maintain the correct gauge, super elevation on curves and removal of creep etc.</li><li>5. He should see the welfare of his gangman.</li><li>6. He should supervise the work of his gang regularly.</li><li>7. Level crossing under his charge must be maintained in perfect condition. During the visit to level crossing, he should check the working of gateman also. If necessary he should issue instruction to the gateman.</li><li>8. At the time of accident, he is responsible to store the traffic in the shortest possible time. He should also find out the causes of accident.</li><li>9. He should prepare the estimates of the maintenance work and should report the progress to his seniors.</li></ol> | <b>1<br/>mark<br/>each<br/>(Any<br/>four)</b> | <b>4</b>    |

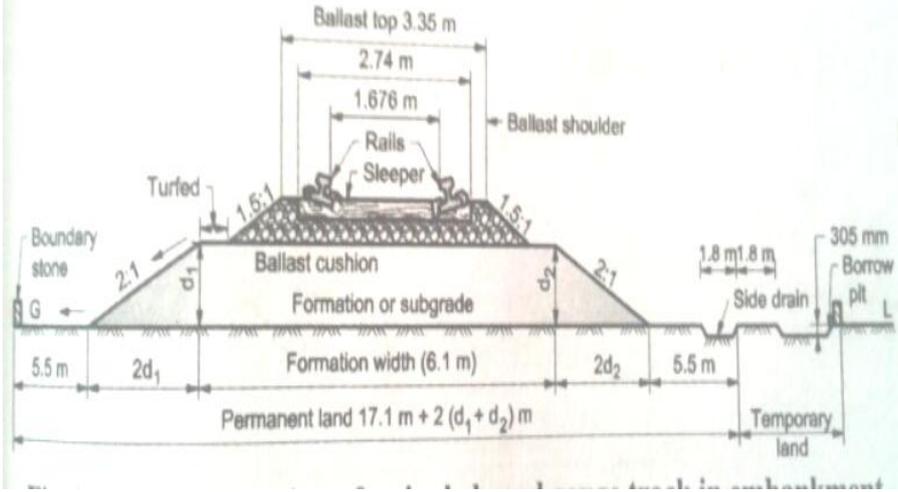


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|----------|-----------|---|-------------------------------|-------------|
| Q.2      | d)        | <p><b>Which data is required to be collected for design of bridge?</b><br/><b>Ans.</b><br/>Following data are required for design of the bridge;</p> <p><b>1. General Data:</b></p> <ul style="list-style-type: none"><li>• This data includes maps, plans and topographical features of the proposed bridge site. Various drawing is required at the time of investigation like under map, contour survey plan, site plan, cross sections, longitudinal sections, catchment area map.</li></ul> <p><b>2. Geological Data:</b> This data includes following information;</p> <ul style="list-style-type: none"><li>• Nature &amp; properties of existing soil in bed, banks and approaches.</li><li>• Safe bearing capacity of the foundation soil.</li><li>• Liability of the site to earthquake disturbances and its magnitude.</li></ul> <p><b>3. Hydraulic Data:</b></p> <ul style="list-style-type: none"><li>• This data includes following information.</li><li>• Intensity and frequency of rainfall in the catchment area.</li><li>• Hydrograph for one or more years.</li><li>• Size, shape and surface characteristic of catchment are including percolation and interception.</li><li>• Observed maximum depth of scour.</li></ul> <p><b>4. Climate Data:</b></p> <ul style="list-style-type: none"><li>• This data includes information regarding annual temperature range, cyclones, wind velocity, rainfall, characteristics, and relative humidity.</li></ul> <p><b>5. Loading and other data:</b></p> <ul style="list-style-type: none"><li>• Live load for which the bridge is to be designed as per IRC Code of practice</li><li>• Type of Stream</li><li>• LWL, HFL, ordinary flood level</li><li>• Type and nature of stream</li><li>• Velocity of stream</li><li>• Seismic conditions of area</li></ul> | <b>1 mark each (Any four)</b> | <b>4</b>    |



| Que. No. | Sub. Que. | Model Answers  | Marks      | Total Marks |
|----------|-----------|--|------------|-------------|
| Q.2      | e)        | <p><b>Define abutment of a bridge. State its functions.</b></p> <p><b>Ans.</b></p> <p><b>Abutment:</b><br/>The end supports of a bridge superstructure are known as abutments. They are built either with brick masonry, stone masonry, mass concrete, precast concrete blocks or R.C.C.</p> <p><b>The functions of abutment are as follows;</b></p> <ol style="list-style-type: none"><li>1. To retain the earth pressure of embankment of the approaches.</li><li>2. To support the bridge superstructure and to transmit the load from it to the subsoil lying underneath.</li></ol>  | 2<br>marks | 4           |
|          | f)        | <p><b>With the help of neat sketch explain prestressed girder bridge.</b></p> <p><b>Ans.</b></p>  <p>( Note- any other relevant sketch should be considered )</p> <ol style="list-style-type: none"><li>1. Prestressing of concrete bridges has resulted in longer and slender spans, improved aesthetics and increased economy in construction.</li><li>2. With prestressing, the slab bridges can have the spans in range of 20 -40 m while slab-beam (T-beam) can have span range of 10 – 20 m.</li><li>3. Prestressed concrete bridges include a wide variety of different forms, from cast in situ to precast, from beams to box girders, and from simply supported to cable stayed.</li><li>4. Prestressing of a bridge involves application of external force to the concrete by the use of wires, strands or bars and this greatly increase the strength of concrete.</li></ol> | 2<br>marks | 4           |

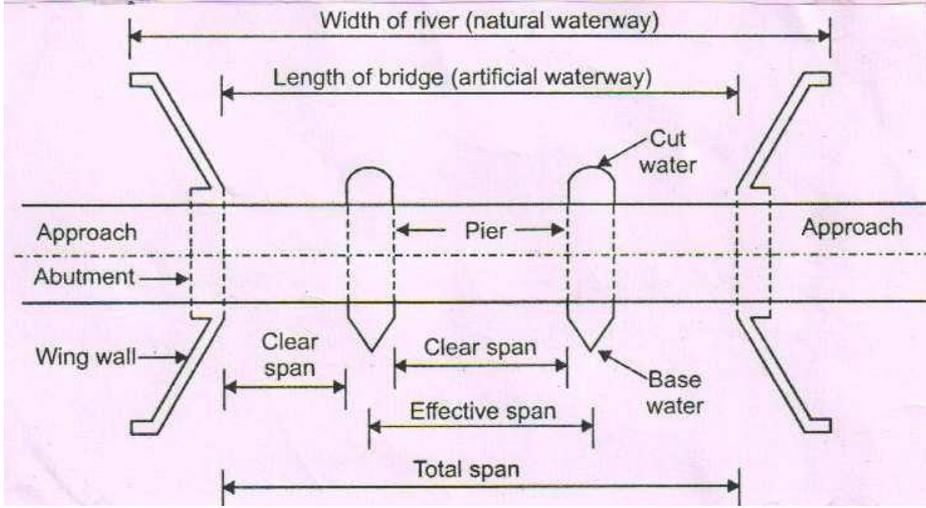


| Que. No. | Sub. Que. | Model Answers  | Marks | Total Marks |
|----------|-----------|--|-------|-------------|
| Q.3      |           | <p>Attempt any <u>TWO</u> of the following:</p> <p>a) Draw neat Cross section of Broad Gauge (B.G.) single track in embankment and label its parts.</p> <p>Ans.</p>  <p>Fig: Cross section of a single broad gauge track in embankment</p> <p><i>Note: 4 marks for sketch and 4 marks for labeling.</i></p> | 8     | 8           |



| Que. No. | Sub. Que.   | Model Answers  | Marks                      | Total Marks |               |   |   |   |   |   |  |   |   |  |   |   |   |   |   |   |   |   |   |   |  |  |                            |   |   |   |                            |   |                            |   |
|----------|---|--|----------------------------|-------------|---------------|---|---|---|---|---|--|---|---|--|---|---|---|---|---|---|---|---|---|---|--|--|----------------------------|---|---|---|----------------------------|---|----------------------------|---|
| Q.3      | b)  | <p><b>Differentiate fish plate and bearing plate.</b></p> <p><b>Ans.</b></p> <table border="1"> <thead> <tr> <th>Sr. No.</th> <th>Fish plate</th> <th>Bearing plate</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>These plates are used to join one rail with other rail.</td> <td>These are provided in between the flat footed rail and wooden sleepers.</td> </tr> <tr> <td>2</td> <td>Two fish plates are placed on either sides of the rail.</td> <td>Bearing plates are normally used under at rail joints.</td> </tr> <tr> <td>3</td> <td>Fish plates are used at every rail joint.</td> <td>Bearing plates are used on curves and under points and crossing.</td> </tr> <tr> <td>4</td> <td>It helps in maintaining alignment of railway track.</td> <td>It helps in protecting sleeper from sinking and damage.</td> </tr> <tr> <td>5</td> <td>It helps in minimizing variation caused by temperature and prevents expansion and contraction of rails.</td> <td>It helps in fastening to remain in position under varying load.</td> </tr> <tr> <td>6</td> <td>By providing fish plates, points and crossings are properly maintained.</td> <td>It increases life of sleepers and helps for smooth running of trains.</td> </tr> <tr> <td>7</td> <td> </td> <td> </td> <td rowspan="2">1 mark each (eight points)</td> <td rowspan="2">8</td> </tr> <tr> <td>8</td> <td> <p><b>c) Explain ideal requirements of permanent way.</b></p> <p><b>Ans.</b></p> <ol style="list-style-type: none"> <li>The level of both rails should be same.</li> <li>It should resist lateral forces.</li> <li>Gradient should be easy and uniform.</li> <li>The gauge of permanent way should be uniform and correct.</li> <li>On curved position of the track, proper elevation should be provided between outer rails to inner rail.</li> <li>Alignment should be correct.</li> <li>Joints, crossing should be designed properly.</li> <li>Track should have electricity.</li> </ol> </td> <td>1 mark each (eight points)</td> <td>8</td> </tr> </tbody> </table> | Sr. No.                    | Fish plate  | Bearing plate | 1 | These plates are used to join one rail with other rail. | These are provided in between the flat footed rail and wooden sleepers. | 2 | Two fish plates are placed on either sides of the rail. | Bearing plates are normally used under at rail joints. | 3 | Fish plates are used at every rail joint. | Bearing plates are used on curves and under points and crossing. | 4 | It helps in maintaining alignment of railway track. | It helps in protecting sleeper from sinking and damage. | 5 | It helps in minimizing variation caused by temperature and prevents expansion and contraction of rails. | It helps in fastening to remain in position under varying load. | 6 | By providing fish plates, points and crossings are properly maintained. | It increases life of sleepers and helps for smooth running of trains. | 7 |  |  | 1 mark each (eight points) | 8 | 8 | <p><b>c) Explain ideal requirements of permanent way.</b></p> <p><b>Ans.</b></p> <ol style="list-style-type: none"> <li>The level of both rails should be same.</li> <li>It should resist lateral forces.</li> <li>Gradient should be easy and uniform.</li> <li>The gauge of permanent way should be uniform and correct.</li> <li>On curved position of the track, proper elevation should be provided between outer rails to inner rail.</li> <li>Alignment should be correct.</li> <li>Joints, crossing should be designed properly.</li> <li>Track should have electricity.</li> </ol> | 1 mark each (eight points) | 8 | 1 mark each (eight points) | 8 |
| Sr. No.  | Fish plate  | Bearing plate  |                            |             |               |   |   |   |   |   |  |   |   |  |   |   |   |   |   |   |   |   |   |   |  |  |                            |   |   |   |                            |   |                            |   |
| 1        | These plates are used to join one rail with other rail.   | These are provided in between the flat footed rail and wooden sleepers.  |                            |             |               |   |   |   |   |   |  |   |   |  |   |   |   |   |   |   |   |   |   |   |  |  |                            |   |   |   |                            |   |                            |   |
| 2        | Two fish plates are placed on either sides of the rail.   | Bearing plates are normally used under at rail joints.   |                            |             |               |   |   |   |   |   |  |   |   |  |   |   |   |   |   |   |   |   |   |   |  |  |                            |   |   |   |                            |   |                            |   |
| 3        | Fish plates are used at every rail joint.   | Bearing plates are used on curves and under points and crossing.   |                            |             |               |   |   |   |   |   |  |   |   |  |   |   |   |   |   |   |   |   |   |   |  |  |                            |   |   |   |                            |   |                            |   |
| 4        | It helps in maintaining alignment of railway track.   | It helps in protecting sleeper from sinking and damage.  |                            |             |               |   |   |   |   |   |  |   |   |  |   |   |   |   |   |   |   |   |   |   |  |  |                            |   |   |   |                            |   |                            |   |
| 5        | It helps in minimizing variation caused by temperature and prevents expansion and contraction of rails.   | It helps in fastening to remain in position under varying load.  |                            |             |               |   |   |   |   |   |  |   |   |  |   |   |   |   |   |   |   |   |   |   |  |  |                            |   |   |   |                            |   |                            |   |
| 6        | By providing fish plates, points and crossings are properly maintained.   | It increases life of sleepers and helps for smooth running of trains.  |                            |             |               |   |   |   |   |   |  |   |   |  |   |   |   |   |   |   |   |   |   |   |  |  |                            |   |   |   |                            |   |                            |   |
| 7        |   |  | 1 mark each (eight points) | 8           |               |   |   |   |   |   |  |   |   |  |   |   |   |   |   |   |   |   |   |   |  |  |                            |   |   |   |                            |   |                            |   |
| 8        | <p><b>c) Explain ideal requirements of permanent way.</b></p> <p><b>Ans.</b></p> <ol style="list-style-type: none"> <li>The level of both rails should be same.</li> <li>It should resist lateral forces.</li> <li>Gradient should be easy and uniform.</li> <li>The gauge of permanent way should be uniform and correct.</li> <li>On curved position of the track, proper elevation should be provided between outer rails to inner rail.</li> <li>Alignment should be correct.</li> <li>Joints, crossing should be designed properly.</li> <li>Track should have electricity.</li> </ol> | 1 mark each (eight points)   |                            |             | 8             |   |   |   |   |   |  |   |   |  |   |   |   |   |   |   |   |   |   |   |  |  |                            |   |   |   |                            |   |                            |   |
|          |   |  | 1 mark each (eight points) | 8           |               |   |   |   |   |   |  |   |   |  |   |   |   |   |   |   |   |   |   |   |  |  |                            |   |   |   |                            |   |                            |   |

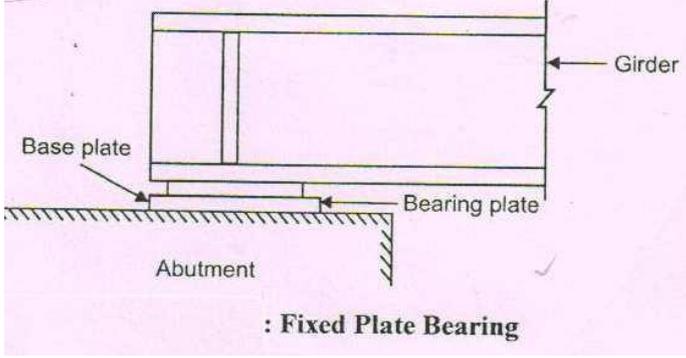
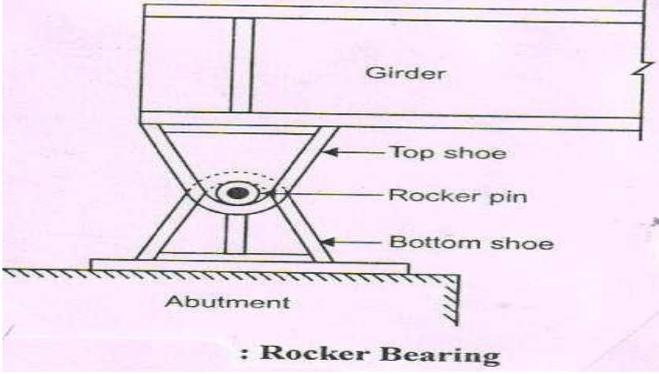
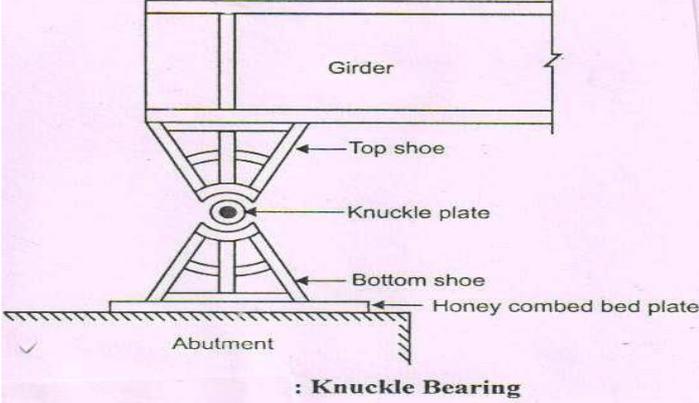
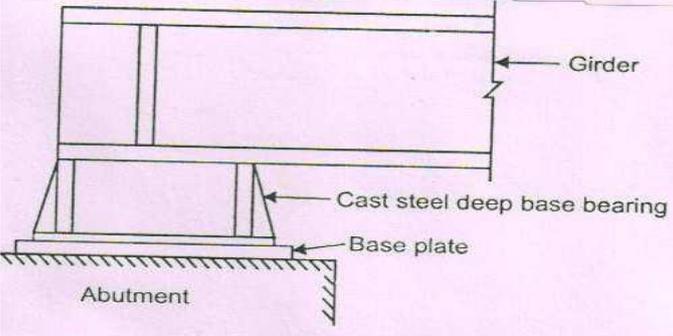


| Que. No. | Sub. Que. | Model Answers   | Marks          | Total Marks |
|----------|-----------|---|----------------|-------------|
| Q.4      |           | <b>Attempt any <u>TWO</u> of the following:</b>   |                | <b>16</b>   |
|          | a)        | <b>Draw plan of bridge showing all important component parts. Also define the following terms.</b><br><b>(i) Effective span</b><br><b>(ii) Afflux</b><br><b>(iii) Water Way</b><br><b>(iv) Wing wall</b><br><b>Ans.</b> |                |             |
|          |           |    | <b>4 marks</b> | <b>8</b>    |
|          |           | i. <b>Effective span:</b> The center to center distance between any two adjacent supports of the bridge superstructure is called effective span.  | <b>1 mark</b>  |             |
|          |           | ii. <b>Afflux:</b> The maximum increase in water level due to obstruction in the path of flow of water is called as afflux.   | <b>1 mark</b>  |             |
|          |           | iii. <b>Waterway:</b> It is the area of opening, which should be sufficient to pass the maximum flood discharge that would ever parts under bridge, without increasing velocity to a dangerous limit.                   | <b>1 mark</b>  |             |
|          |           | iv. <b>Wing wall:</b> The walls constructed at both ends of the abutments to retain the earth banks of the river or of the bridge approaches are known as wing walls.   | <b>1 mark</b>  |             |

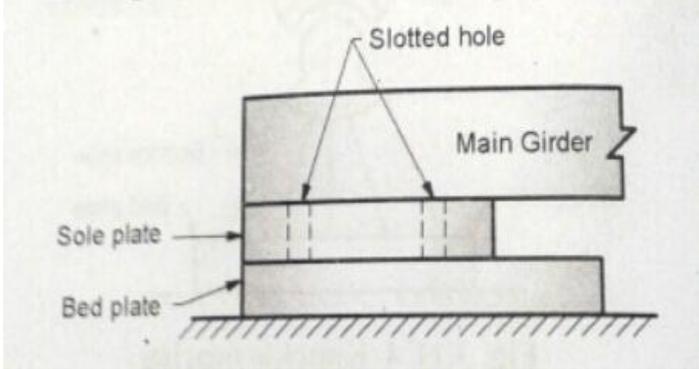
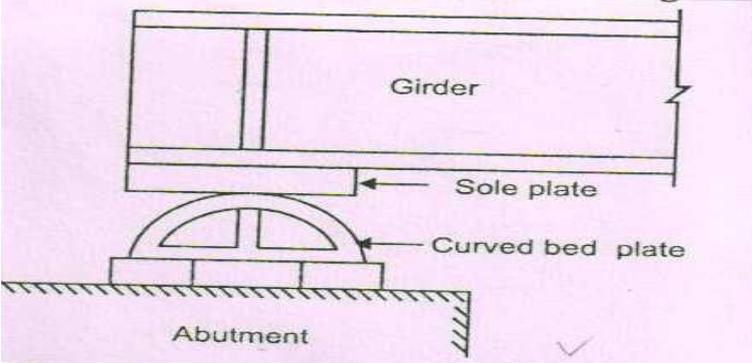
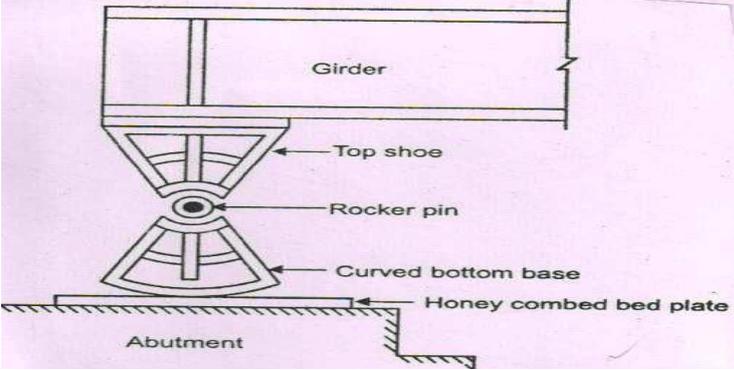
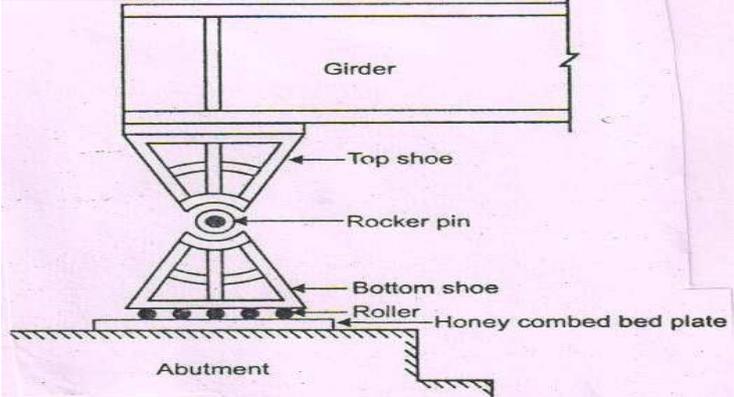


| Que. No. | Sub. Que. | Model Answers   | Marks  | Total Marks |
|----------|-----------|---|--|-------------|
| Q.4      | b)        | <p><b>Classify bridges according to function, materials, span and according to level of bridge floor.</b></p> <p><b>Ans.</b></p> <p>Bridges can be classified into various types depending upon the following factors and condition;</p> <p><b>1. According to functions:</b></p> <ol style="list-style-type: none"><li>Aqueducts</li><li>Viaducts</li><li>Foot bridges</li><li>Highway bridges</li><li>Railway bridges</li></ol> <p><b>2. According to materials:</b></p> <ol style="list-style-type: none"><li>Timber bridges</li><li>Masonry bridges</li><li>Steel bridges</li><li>Reinforced cement concrete bridges</li><li>Prestressed concrete bridges</li></ol> <p><b>3. According to span length:</b></p> <ol style="list-style-type: none"><li>Culverts</li><li>Minor bridges</li><li>Major bridges</li><li>Long span bridges</li></ol> <p><b>4. According to level of bridge floor:</b></p> <ol style="list-style-type: none"><li>Deck bridge</li><li>Semi through bridge</li><li>Through bridge</li></ol> | 2<br>marks<br><br>2<br>marks<br><br>2<br>marks<br><br>2<br>marks           | 8           |
|          | c)        | <p><b>Give the requirements of ideal bearings and state types of bearings for steel bridges along with suitable sketches.</b></p> <p><b>Ans.</b></p> <p><b>Requirements of Bearing:</b></p> <ol style="list-style-type: none"><li>It should be capable to distribute the superimposed load uniformly on substructure.</li><li>The maintenance cost should be minimum.</li><li>It should be easy to install &amp; compact in size.</li><li>It should provide greater stability to the structure.</li></ol> <p><b>Types of Bearing:</b></p> <p>A. Fixed Bearing:</p> <ol style="list-style-type: none"><li>Fixed Plate Bearing</li><li>Deep Base Bearing</li><li>Rocker Bearing</li><li>Knuckle Bearing</li></ol> <p>B. Expansion Bearing:</p> <ol style="list-style-type: none"><li>Sliding Plate Bearing</li><li>Deep cast with curve plate</li><li>Rocker bearing with curved base</li><li>Rocker &amp; roller bearing</li></ol>   | 2<br>marks<br>(Any<br>two)<br><br>1 mark<br>(Any<br>six<br>with<br>sketch) | 8           |

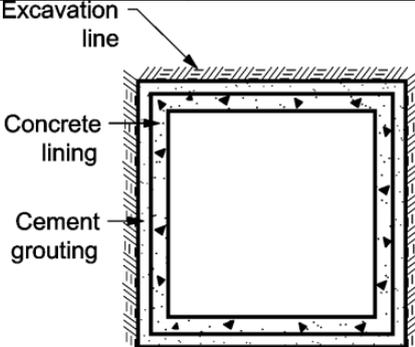
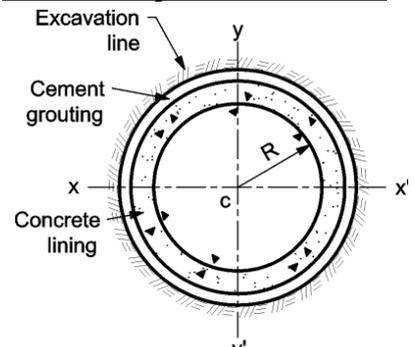


| Que. No. | Sub. Que. | Model Answers  | Marks | Total Marks |
|----------|-----------|--|-------|-------------|
|          |           | <p data-bbox="336 347 587 414"><u>A. Fixed Bearing:</u><br/><u>Fixed Plate Bearing</u></p>  <p data-bbox="708 730 967 763">: Fixed Plate Bearing</p> <p data-bbox="336 813 536 846"><u>Rocker Bearing</u></p>  <p data-bbox="703 1193 967 1227">: Rocker Bearing</p> <p data-bbox="336 1263 552 1296"><u>Knuckle Bearing</u></p>  <p data-bbox="735 1675 967 1709">: Knuckle Bearing</p> <p data-bbox="336 1747 584 1780"><u>Deep Base Bearing</u></p>  <p data-bbox="651 2134 935 2168">: Deep Base Bearings</p> |       |             |

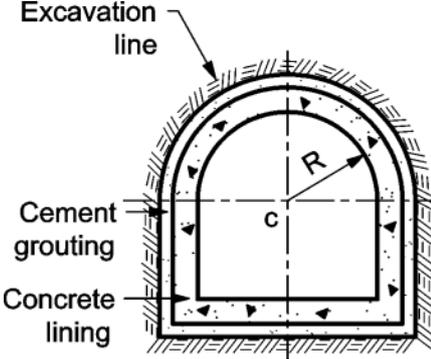
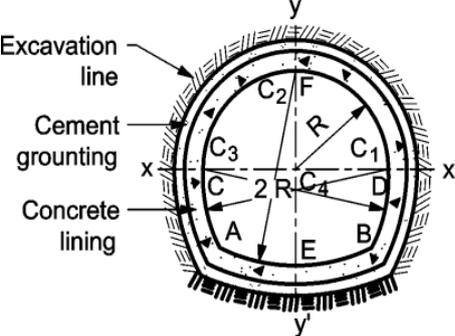
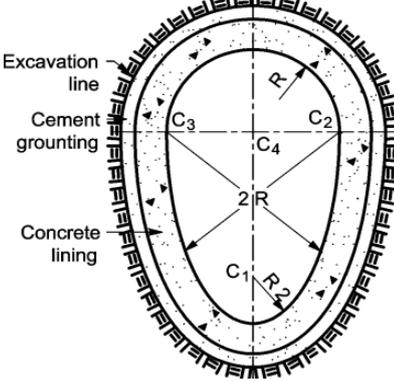
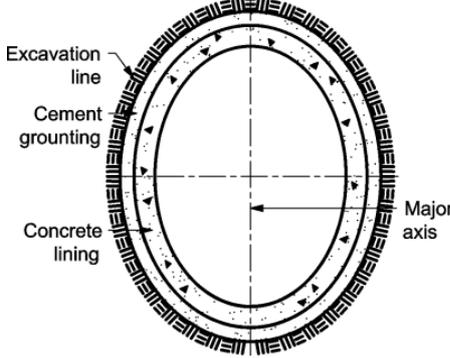


| Que. No. | Sub. Que. | Model Answers   | Marks | Total Marks |
|----------|-----------|---|-------|-------------|
|          |           | <p data-bbox="336 344 624 416">B. Expansion Bearing:<br/><u>Sliding Plate Bearing</u></p>  <p data-bbox="336 831 678 864"><u>Deep cast with curve plate</u></p>  <p data-bbox="336 1267 762 1301"><u>Rocker bearing with curved base</u></p>  <p data-bbox="336 1711 639 1744"><u>Rocker &amp; roller bearing</u></p>  |       |             |



| Que. No. | Sub. Que. | Model Answers   | Marks   | Total Marks |
|----------|-----------|---|---|-------------|
| Q.5      | a)        | <p><b>Attempt any <u>TWO</u> of the following:</b></p> <p><b>Classify tunnels according to shape and size, according to position of alignment, materials (type of soil) and purposes, with necessary suitable sketches.</b></p> <p><b>Ans.</b></p> <p><b><u>According to the size and shape:</u></b></p> <ol style="list-style-type: none"> <li>1. Rectangular or box type shape</li> <li>2. Circular shape</li> <li>3. Segmental shape</li> <li>4. Horse shoe shape</li> <li>5. Egg type shape</li> <li>6. Elliptical shape</li> <li>7. Poly – centric shape</li> </ol> <p><i>Note: 1 mark for type of tunnel and 1 mark for sketch.</i></p> <p><b><u>According to the position of alignment:</u></b></p> <ol style="list-style-type: none"> <li>1. Saddle and base tunnels</li> <li>2. Spiral tunnels</li> <li>3. Off spur tunnels</li> <li>4. Slope tunnels</li> </ol> <p><b><u>According to the type of material:</u></b></p> <ol style="list-style-type: none"> <li>1. Tunnels in hard rock</li> <li>2. Tunnels in soft rock</li> <li>3. Tunnels in quick sand</li> <li>4. Tunnels under river bed</li> </ol> <p><b><u>According to the purpose:</u></b></p> <ol style="list-style-type: none"> <li>1. Traffic tunnel :               <ol style="list-style-type: none"> <li>a) Railway tunnels</li> <li>b) Highway tunnels</li> <li>c) Pedestrian tunnels</li> <li>d) Navigation tunnels</li> <li>e) Subway tunnels</li> </ol> </li> <li>2. Conveyance tunnel :               <ol style="list-style-type: none"> <li>a) Hydro power tunnels</li> <li>b) Water supply tunnels</li> <li>c) Sewage tunnels</li> <li>d) Tunnels for industrial use</li> </ol> </li> </ol> | <p><b>2 marks each (Any two)</b></p> <p><b>1 mark (Any two)</b></p> <p><b>1 mark (Any two)</b></p> <p><b>1 mark (Any two)</b></p> | <b>16</b>   |
|          |           | <p><b><u>Rectangular shaped tunnel section</u></b></p>  <p><b><u>Circular shaped tunnel section</u></b></p>    |   |             |

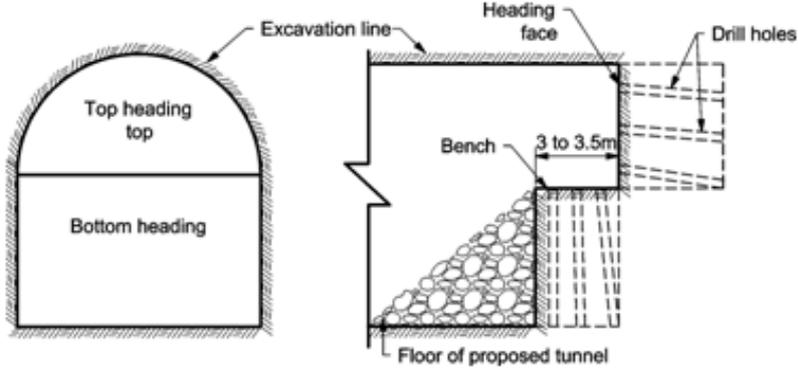
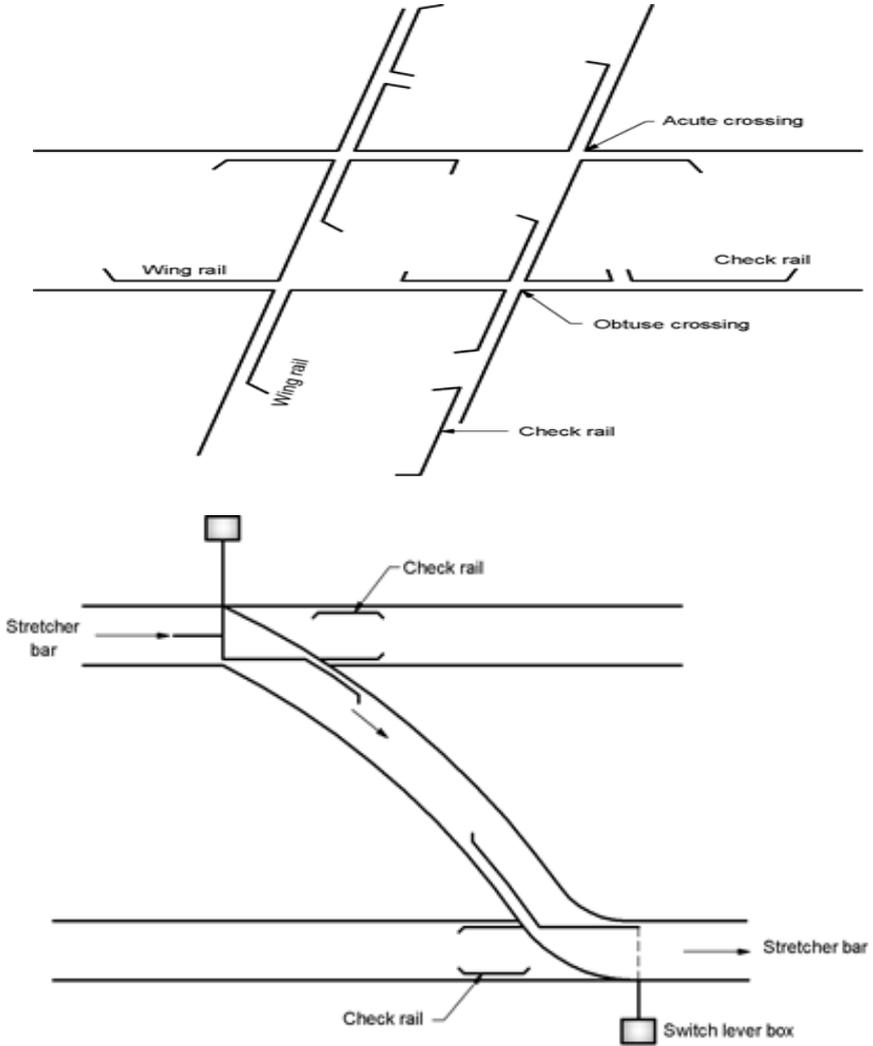


| Que. No. | Sub. Que. | Model Answers   | Marks | Total Marks |
|----------|-----------|---|-------|-------------|
| Q.5      |           | <p data-bbox="336 383 758 416"><u>Segmental shaped tunnel section</u></p>  <p data-bbox="815 383 1236 416"><u>Horse-shoe shaped tunnel section</u></p>  <p data-bbox="336 898 675 931"><u>Egg-shaped tunnel section</u></p>  <p data-bbox="815 898 1217 931"><u>Elliptical shaped tunnel section</u></p>  |       |             |

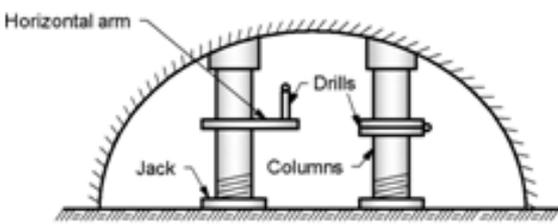
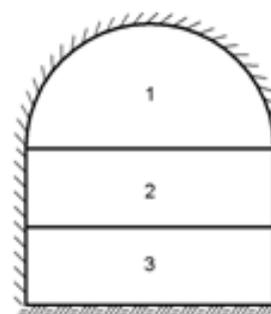


| Que. No. | Sub. Que. | Model Answers   | Marks   | Total Marks     |
|----------|-----------|---|---|-----------------|
| Q.5      | b)        | <p><b>Define lining of tunnel and tunnel ventilation. State purposes of both in detail.</b></p> <p><b>Ans.</b></p> <p><b><u>Tunnel Lining:</u></b><br/>A layer of timber, iron, masonry or concrete provided on the inside of a tunnel is known as lining.</p> <p><b><u>Tunnel ventilation:</u></b><br/>The art of providing freshness of air inside tunnels during or after their construction is known as ventilation in tunnels.</p> <p><b><u>Purpose of lining :</u></b></p> <ol style="list-style-type: none"><li>1. To provide the correct, desired shape to the tunnel.</li><li>2. To support the loosened rock pieces during blasting.</li><li>3. To increase the structural strength of soft places in the tunnel.</li><li>4. To improve the appearance of tunnel.</li><li>5. To prevent percolation of water inside the tunnel.</li><li>6. To reduce the maintenance cost of tunnel.</li><li>7. To house electrical fitting.</li><li>8. To withstand soil pressure when driven in soft rocks.</li></ol> <p><b><u>Purpose of tunnel ventilation:</u></b></p> <ol style="list-style-type: none"><li>1. To supply fresh air inside the tunnel.</li><li>2. To remove poisonous gases, dust smoke etc.</li><li>3. To reduce temperature in tunnel situated at great depth.</li><li>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.</li></ol> | <p><b>1<br/>marks</b></p> <p><b>1<br/>marks</b></p> <p><b>1<br/>marks<br/>each<br/>(Any<br/>three)</b></p> <p><b>1<br/>marks<br/>each<br/>(Any<br/>three)</b></p> | <p><b>8</b></p> |
|          | c)        | <p><b>Describe heading and bench method of tunneling in hard rock with neat sketch.</b></p> <p><b>Ans.</b></p> <p><b><u>Heading and bench method :</u></b><br/>This method is suitable when large section of the proposed tunnel is to be drive and the quality of rock is not very satisfactory.</p> <ol style="list-style-type: none"><li>1. In this method, the driving of the tunnel is done in two portions of its section.</li><li>2. The top portion is known as heading and bottom portion is known as bench.</li><li>3. The driving of top portion is done in advance of the bottom portion</li><li>4. In this method of tunnelling the top portion or heading will be about 3 to 3.5 m ahead of the bottom portion</li><li>5. The holes are drilled into head and bench.</li><li>6. Then these holes are loaded together with explosive and then blasted.</li><li>7. Firing of bench holes is done just before the heading holes are fired.</li><li>8. After this mucking is done manually.</li></ol>   | <p><b>5<br/>marks</b></p>   |                 |



| Que. No. | Sub. Que. | Model Answers   | Marks   | Total Marks |
|----------|-----------|---|---------|-------------|
| Q.5      |           |  <p>(a) Cross section                      (b) Longitudinal section<br/>Heading and bench method</p>  | 3 marks | 8           |
| Q.6      |           | <p>Attempt any <b>FOUR</b> of the following:</p> <p>a) Draw the line sketch diamond crossing and cross over.<br/>Ans.</p>  <p>Note: 1 mark for Sketch and 1 mark for Labeling, for each diagram</p> | 2 marks | 16          |
|          |           |   | 2 marks | 4           |
|          |           |   | 2 marks |             |



| Que. No. | Sub. Que. | Model Answers  | Marks       | Total Marks |
|----------|-----------|--|-------------|-------------|
| Q.6      | b)        | <p><b>Identify different operations involved in tunneling in hard rock.</b></p> <p><b>Ans.</b></p> <p>For tunneling in a hard rock, the following operations are usually carried out;</p> <ol style="list-style-type: none"><li>1. Setting – up and drilling</li><li>2. Loading holes and firing the explosives</li><li>3. Ventilation and removing dust</li><li>4. Mucking</li><li>5. Removing ground water</li><li>6. Timbering if necessary</li><li>7. Grouting</li><li>8. Lining</li></ol>   | ½ mark each | 4           |
|          | c)        | <p><b>Explain full face method of tunneling with neat sketch,</b></p> <p><b>Ans.</b></p> <p><b><u>Full - face heading method:</u></b></p> <ol style="list-style-type: none"><li>1. In this method whole section of the tunnel is attacked at the same time, this method is called as full - face heading methods.</li><li>2. 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.</li><li>3. The drill holes are charged with explosive and ignited at a time.</li><li>4. The size of the hole may vary from 10mm to 40mm.</li><li>5. The muck is removed before the next operation of drilling holes.</li><li>6. In this method progress of work is more as compare to other methods. Mucking can be done easily.</li><li>7. This method is not suitable for unstable rock.</li></ol> <div style="display: flex; justify-content: space-around; align-items: flex-end;"><div style="text-align: center;"><p>(a) When tunnel is small</p></div><div style="text-align: center;"><p>(b) When tunnel is large</p></div></div> <p style="text-align: center;">Full face heading method</p> | 2 marks     | 4           |





| Que. No. | Sub. Que. | Model Answers   | Marks  | Total Marks     |
|----------|-----------|---|--|-----------------|
| Q.6      | f)        | <p><b>What is tunnel investigation? State its necessity in detail.</b></p> <p><b>Ans.</b></p> <p><b><u>Tunnel Investigations :</u></b><br/>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.</p> <p><b><u>Necessity for tunnel investigation</u></b></p> <ol style="list-style-type: none"><li>1. To locate underground presence of water, fault planes etc, so as to overcome problems which are likely to occur during tunneling.</li><li>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.</li><li>3. Tunnel should pass through the hard rock, as the chances of accidents are much less as compared to soft rock.</li><li>4. The alignment should be such that the excavation work is minimum.</li><li>5. The alignment should not be near water channel.</li><li>6. The portal of the tunnel should be near the dumping yard so that the muck may be disposed of in lesser time.</li><li>7. The alignment should be as straight as possible.</li><li>8. Minimum possible grade should be provided in tunnel.</li></ol> <p>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.</p> | <p><b>1<br/>mark</b></p> <p><b>1<br/>mark<br/>each<br/>(Any<br/>three)</b></p> | <p><b>4</b></p> |