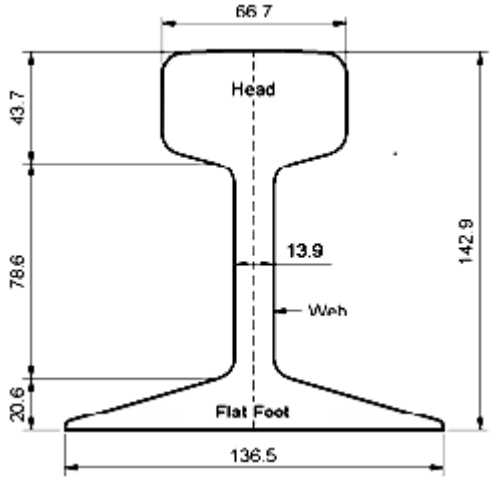
# Model Answer: Winter- 2019

**Subject: Transportation Engineering** | **Sub. 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.

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
|---|---|---|---|---|
| **Q.1** | | **Attempt any TEN of the following:** | | **20** |
| | **a)** | **State the role of transportation in the development of nation.** | | |
| | **Ans.** | Role of transportation is an essential accessory of development of nation for the following purposes :<br>1. Easy and quick transportation of men, machines, animals, materials and goods can be made.<br>2. Areas which are connected by proper means of transport can be developed fast.<br>3. Remote areas and rural areas become accessible and communicable if connected by proper means of transport.<br>4. During the days of emergency e.g. wars, efficient and developed transportation system plays a vital role for quick and easy transportation of soldiers, food and ammunition.<br>5. Transportation through airways also plays an important role of communication to the people staying in remote areas and also helps the people in difficulties during floods. E.g. Helicopters can help the people at the time of floods. | **1 each (any two)** | **2** |
| | **b)** | **State the different types of modes of transportation.** | | |
| | **Ans.** | 1. Roadways<br>2. Railways<br>3. Airways<br>4. Waterways | **½ each** | **2** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
|---|---|---|---|---|
| Q.1 | c) Ans. | **State the importance of cross drainage works.**<br>1. The cross drainage work helps to maintain the continuity of a road or a railway track while going across the river, streams, nala depressions and valleys.<br>2. It also maintains the gradient in undulating area in case of railway.<br>3. It provides the continuous access to the surrounding villages and towns even at the time of flood and heavy rain.<br>4. It helps to drain the water by providing the structure called as scuppers in hilly areas.<br>5. It maintains the continuous communications. | **1 each (any two)** | **2** |
| | d) Ans. | **Enlist the types of gauge.**<br>**Different types of gauges of railway track:**<br>1. Broad Gauge (1676 mm)<br>2. Meter Gauge (1000 mm)<br>3. Narrow Gauge ( 762 mm or 610 mm) | **2** | **2** |
| | e) Ans. | **Define permanent way.**<br>**Permanent way**<br>The permanent way is the combination of ballast; rails and Fixtures. It consists of a pair of rails fixed to sleepers which rest on ballast. | **2** | **2** |
| | f) Ans. | **Draw a sketch of flat footed rail.**<br>  <br><br>**Fig. :Flat Footed Rail** | **2** | **2** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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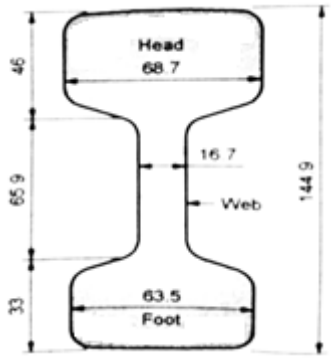
| Q.1 | g) Ans. | **Draw a sketch of bull headed rail.**<br>  <br><br>**Fig. :Bull Headed Rail** | **2** | **2** |
| | h) Ans. | **Define afflux.**<br>**Afflux:**<br>The maximum increase in water level due to obstruction in the path of flow of water is called as afflux. | **2** | **2** |
| | i) Ans. | **Define effective span.**<br>**Effective span:**<br>The center to center distance between any two adjacent supports of the bridge superstructure is called span or effective span of bridge. | **2** | **2** |
| | j) Ans. | **Classify bridge according to alignment.**<br>**According to alignment:**<br>1. Straight bridges<br>2. Skew bridges | **1 each** | **2** |
| | k) Ans. | **Enlist the types of pier.**<br>**Types of piers:**<br>**I. Solid piers:**<br>i. Solid masonry piers<br>ii. Solid R.C.C. piers<br>**II. Open piers:**<br>i. Column bents<br>ii. Pile bents<br>iii. Cylindrical piers<br>iv. Trestle piers | **1 each** | **2** |
| | l) Ans. | **Define Tunnel.**<br>**Tunnel:**<br>The underground passages which are constructed without disturbing the ground surface are known as tunnels. | **2** | **2** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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| Q.1 | m) Ans. | **Enlist the classification of tunnel.**<br>**According to the size and shape:**<br>1. Rectangular or box type shape<br>2. Circular shape<br>3. Segmental shape<br>4. Horse shoe shape<br>5. Egg type shape<br>6. Elliptical shape<br>7. Polycentric shape<br>**According to the position of alignment:**<br>1. Saddle and base tunnels<br>2. Spiral tunnels<br>3. Off spur tunnels<br>4. Slope tunnels<br>**According to the type of material:**<br>1. Tunnels in hard rock<br>2. Tunnels in soft rock<br>3. Tunnels in quick sand<br>4. Tunnels under river bed<br>**According to the purpose:**<br>1. Traffic tunnel :<br>a. Railway tunnels<br>b. Highway tunnels<br>c. Pedestrian tunnels<br>d. Navigation tunnels<br>e. Subway tunnels<br>2. Conveyance tunnel :<br>a. Hydro power tunnels<br>b. Water supply tunnels<br>c. Sewage tunnels<br>d. Tunnels for industrial use | ½ each (any four) | 2 |
| | n) Ans. | **Enlist various shapes of tunnel.**<br>The various types of tunnels as per shapes are<br>1. Rectangular or box type shape<br>2. Circular shape<br>3. Segmental shape<br>4. Horse shoe shape<br>5. Egg type shape<br>6. Elliptical shape<br>7. Poly – centric shape | ½ each (any four) | 2 |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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| Q.1 | o) Ans. | **Enlist the types of explosives used in tunneling.**<br>Following are the types of explosives mainly used for tunneling.<br>1. Disruptive explosive<br>2. Power explosive<br>3. Liquid air explosive | 2 | 2 |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
|---|---|---|---|---|
| **Q.2** | | **Attempt any <u>FOUR</u> of the following:** | | **16** |
| | **a)** | **State the factors affecting rail alignment.** | | |
| | **Ans.** | Factors affecting the rail alignment are as follows:<br>1. **Obligatory Points:** 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 requiting deep cutting, etc.<br>2. **Traffic:** 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. **Geometric Designs:** The gradient must not exceed the permissible limits and the curves from economical point of view should be of maximum possible radii.<br>4. **Topography of Area**: According to topography, the alignment of a track may be classified as:<br>5. **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>6. **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>7. **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>8. **Economic Consideration:** The alignment should also be economical. The initial cost of maintenance and vehicle operation cost should be taken into consideration.<br>9. **Other consideration:** 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. | **1 each (any four)** | **4** |
| | **b)** | **State the requirement of railway station.** | | |
| | **Ans.** | **(1) Public requirement:**<br>• A booking office for issuing tickets and for booking of goods. | | |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
|---|---|---|---|---|
| Q.2 | b) | • Passenger and goods platform.<br>• Waiting rooms and retiring rooms.<br>• Name board of station.<br>• Arrangement for drinking water.<br>• W/C and bath room arrangement.<br>• Suitable light arrangement.<br>• An enquiry office.<br>• Microphones to announce arrival and departure of train.<br>• Others like telephone, stalls, telegraph office, police help etc.<br>**(2) Traffic and police requirement:**<br>• Staffroom.<br>• Retiring room and rest houses.<br>• Residential quarters for railway staff.<br>**(3) Trains requirement:**<br>The following arrangement should be there for the control of trains movement :<br>• Arrangement for controlling the movement of trains by signal.<br>• Sufficient number of siding for receiving, sorting, storing and despatching trains.<br>• Sufficient number of platform for handing passenger and goods.<br>**(4) Requirement of locomotive:**<br>The Railway station should provide following facilities for locomotives :<br>• For changing the direction of engine; a turn table must be there.<br>• Arrangement for cleaning, examining, inspecting and maintaining the locomotives such as ash pits, inspection pits, etc. should be provided.<br>• Coal lifting cranes, water columns for supply of fuel and water should be provided.<br>**(5) Requirement for development of railways:**<br>The railway station should provide the following facilities for development of railway:<br>• Easy and comfortable approach roads.<br>• Big waiting halls.<br>• Guide map of city separate arrival and departure of trains.<br>• Sufficient number of coolies on station platform.<br>***(Note: Any other relevant requirement other than above should be considered.)*** | **1 each (any four)** | **4** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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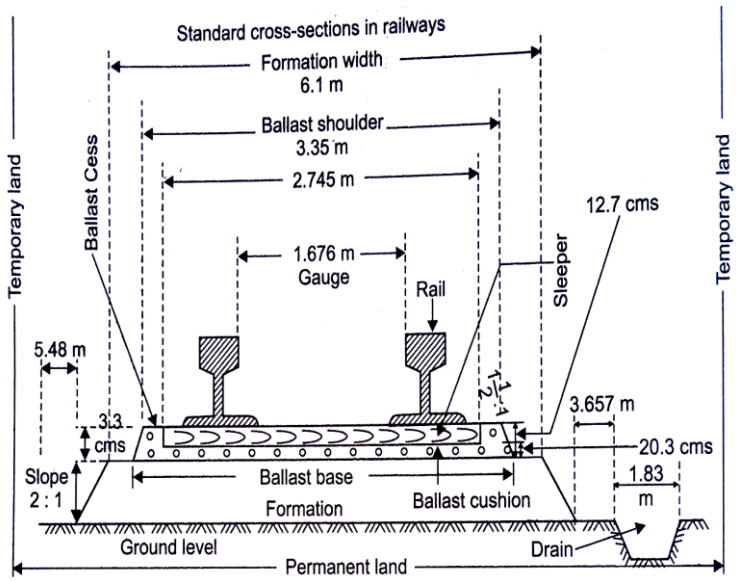
| Q.2 | c) Ans. | **Draw the sketch of standard cross section of single broad gauge line in embankment.**<br>  <br><br>**Fig. :Standard Cross Section of Single Broad Gauge Line in Embankment** | **4** | **4** |
| | d) Ans. | **State the duties of permanent way inspector.**<br>**Duties of permanent way inspector:**<br>The duties of permanent way inspector are as follows;<br>1. The PWI 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.<br>2. He is responsible to carry out the renewals of rails and sleepers.<br>3. He should maintain the record of wear of rails in his section. He should check out the programme for lubrication of rail joints in such a way that the entire rail joint are lubricated on a year during winter season.<br>4. He is responsible to maintain the correct gauge, super elevation on curves and removal of creep etc.<br>5. He should supervise the work of his gang regularly.<br>6. He should see the welfare of his gang man.<br>7. Level crossing under his charge must be maintained in perfect condition. During this visit to level crossing, he should check the working of gateman also. If necessary he should issue | **1 each (any four)** | **4** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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| Q.2 | d) | instructions to the gateman.<br>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.<br>9. He should prepare the estimates of the maintenance work and should report the progress to his seniors.<br>10. It is his responsibility to distribute the work to every APWI, gang mate and key man<br>11. He has to look after station yards also. | | |
| | e)<br>Ans. | **Define creep and state the causes of creep.**<br>**Creep of rail:** Creep in rail is defined as the longitudinal movement of the rails in the track in the direction of motion of locomotives.<br>**Causes of creep of rail:**<br>1) Ware action.<br>2) Percussion theory.<br>3) Accelerating and starting of train.<br>4) De- accelerating or stopping the train.<br>5) Intensity of traffic.<br>6) Alignment of track.<br>7) Gradient of track.<br>8) Expansion and contraction of rails due to variation in temperature.<br>9) Improper consolidation of formation bed of track.<br>10) Insufficient number of ballast is laid.<br>11) Improper packing of ballast. | **1**<br>**1 each (any three)** | **4** |
| | f)<br>Ans. | **State the suitability of following**<br>**(i) Metal sleeper**<br>**(ii) Concrete sleeper**<br>**Suitability:**<br>**(i) Metal sleeper**<br>1. Where lateral and longitudinal stability required is more.<br>2. Greater strength is required.<br>3. Suitable for high speeds and load<br>**(ii) Concrete sleeper**<br>1. These are suitable for welded rail track<br>2. Where less fitting required.<br>3. Suitable where better lateral stability to the track<br>4. suitable for all types of soils<br>5. Suitable for use in track circuited lines | **1 each (any two)**<br>**1 each (any two)** | **4** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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| **Q.3** | | **Attempt any FOUR of the following:** | | **16** |
| | **a)** | **State the requirement and types of rail joint.** | | |
| | **Ans.** | **The requirements of rail joint are as follows:**<br>1. A perfect rail joint should be as strong and stiff as the rail section it self.<br>2. Both the adjoining rail ends at the joints should remain true in line laterally as well as vertically when the train passes over the joint.<br>3. It should provide enough expansion gaps in between the two adjoining ends of rails for the expansion of rails due to variation in temperature.<br>4. It should be elastic both laterally and vertically.<br>5. It should not allow the rail ends to get battered in any case.<br>6. It should facilitate easy removal and replacement of rails without disturbing the whole track.<br>7. It should be economical in its cost of construction as well as maintenance. | **1 each (any two)** | **4** |
| | | **Types of rail joint:**<br>1. Supported rail joint<br>2. Suspended rail joint<br>3. Bridge rail joint<br>4. Welded rail joint<br>5. Square rail joint<br>6. Staggered rail joint<br>7. compromise rail joint<br>8. Insulated rail joint | **1 each (any two)** | |
| | **b)** | **State the requirement of good ballast.** | | |
| | **Ans.** | **Requirement of good ballast:**<br>1. It should be strong and resistant to wear and tear.<br>2. It should be strong resistant against weather.<br>3. It should not create dust that means its crushing strength must be more.<br>4. It should not have any bad effect on rails and metal sleepers.<br>5. It should be cheaply available nearby site.<br>6. It should have angular and rough surface so as to provide stability to the sleepers. | **1 each (any four)** | **4** |
| | **c)** | **Enlist the various fixtures and fastenings of rail.** | | |
| | **Ans.** | **The various fixtures and fastenings of rail:**<br>1)Fish plates 2)Spikes<br>3)Bolts 4)Chairs<br>5)Blocks 6)Keys and cotters | **1 each (any four)** | **4** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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| **Q.3** | | 7)Bearing Plates 8)Anchors | | |
| | **d) Ans.** | **Describe in brief Marshalling yard.**<br>**Marshalling yard:** The yards where trains and other loads are received, sorted out stations wise and new trains are formed and dispatched onwards are known as Marshalling yard.<br>**The functions of a Marshalling yard are as follows:**<br>1. Reception of empty and loaded wagons.<br>2. Sorting of wagons.<br>3. Departure of wagons in the forms of trains.<br>4. New trains are formed and dispatched.<br>5. Distribution center for trains.<br>**Types of Marshalling yard are:**<br>1. Flat yards<br>2. Gravitational yards<br>3. Hump yards | **1**<br><br>**2**<br><br>**1** | **4** |
| | **e) Ans.** | **Enlist various types of data required for design of bridge.**<br><br>Following data are required for design of the bridge;<br>1. **General Data:**<br>• 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.<br>2**. Geological Data:** This data includes following information;<br>• Nature and properties of existing soil in bed, banks and approaches.<br>• Safe bearing capacity of the foundation soil.<br>• Liability of the site to earthquake disturbances and its magnitude.<br>3. **Hydraulic Data:**<br>• This data includes following information.<br>• Intensity and frequency of rainfall in the catchment area.<br>• Hydrograph for one or more years.<br>• Size, shape and surface characteristic of catchment area including percolation and interception.<br>• Observed maximum depth of scour.<br>4. **Climate Data:**<br>• This data includes information regarding annual temperature range, cyclones, wind velocity, rainfall, characteristics, and | **1 each (any four)** | **4** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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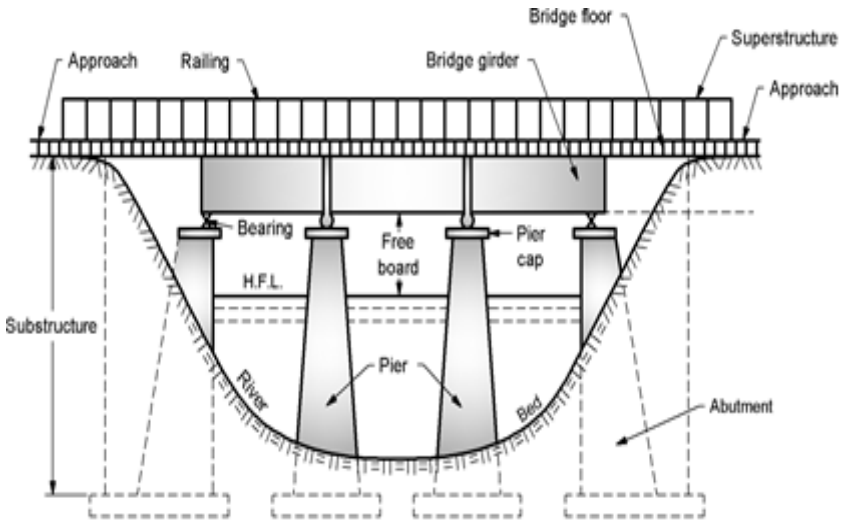
| Q.3 | e) | relative humidity.<br>**5. Loading and other data:**<br>• Live load for which the bridge is to be designed as per IRC Code of practice<br>• Type of Stream<br>• LWL, HFL, ordinary flood level<br>• Type and nature of stream<br>• Velocity of stream<br>• Seismic conditions of area | | |
| | f)<br><br>Ans. | **Draw sectional elevation of bridge and label the parts.**<br>  <br><br>**Fig.: Sectional Elevation of Bridge**<br><br>***(Note: 3 marks for neat sketch and 1 mark for labeling.)*** | **4** | **4** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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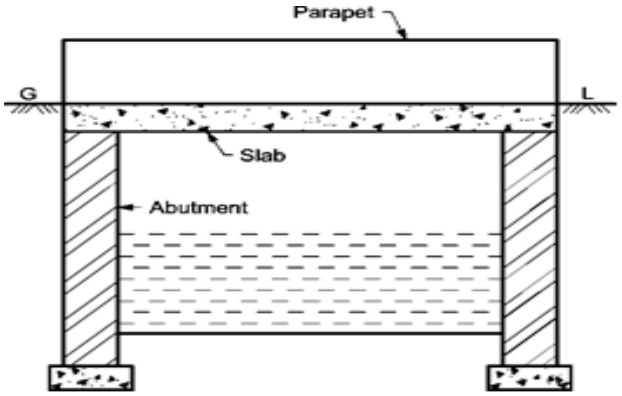
| **Q.4** | | **Attempt any <u>FOUR</u> of the following:** | | **16** |
| | **a)** | **Define wing wall and state the functions of wing wall.** | | |
| | **Ans.** | **Wing wall:** | **2** | |
| | | The walls constructed on either side of an abutment to support and protect the embankment are known as wing walls. | | **4** |
| | | **The functions of wing walls are as follows:** | **1** | |
| | | 1) To retain the earth banks of the river. | **each** | |
| | | 2) To protect the earth banks from the action of water. | **(any** | |
| | | 3) To provide a smooth entry of water into the bridge site. | **two)** | |
| | | 4) To support and protect embankment. | | |
| | **b)** | **State the function and types of abutment.** | | |
| | **Ans.** | **The functions of abutment are as follows:** | **1** | |
| | | 1. To retain the earth pressure of embankment of the approaches. | **each** | |
| | | 2. To support the bridge superstructure and to transmit the load from it to the subsoil lying underneath. | **(any two)** | |
| | | 3. To provide final formation level to the bridge superstructure. | | **4** |
| | | **Types of abutment:** | | |
| | | 1. Abutment without wing walls | | |
| | | • Straight abutment | | |
| | | • Tee abutment | **1** | |
| | | • Hollow abutment | **each** | |
| | | 2. Abutment with wing walls | **(any** | |
| | | • Abutment with straight wing wall | **two)** | |
| | | • Abutment with splayed wing wall | | |
| | | • Abutment with return wing wall | | |
| | **c)** | **Draw a neat sketch of slab culvert.** | | |
| | **Ans.** |  | **4** | **4** |
| | | **Fig. :Slab Culvert** | | |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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| Q.4 | d) Ans. | **State the requirements of ideal bearing.**<br>**Requirements of Bearing:**<br>1. It should be capable to distribute the superimposed load uniformly on substructure.<br>2. The maintenance cost should be minimum.<br>3. It should be easy to install and compact in size.<br>4. It should provide greater stability to the structure.<br>5. It should compensate internal stresses properly.<br>6. It should sufficiently capable of allowing angular movement and vertical movement.<br>7. It should allow longitudinal movement due to variation in temperature. | **1 each (any four)** | **4** |
| | e) Ans. | **Describe in brief temporary bridges.**<br>Temporary bridge: The bridges which can be constructed as well as maintained at low cost and have short span of useful life are known as temporary bridges or low cost bridges.<br>**Purposes of temporary bridge**<br>1. At the time of flood, it plays very important role in rescue operation.<br>2. To divert the waterway, at the time of bridge construction.<br>3. To give the transportation facility for men, animal, light weight vehicles etc. at the time of maintenance of main bridge.<br>4. To connect shorelines temporary at the time of heavy rainfall.<br>5. At the time of war, it plays very important role in military operations.<br>**Temporary bridges are classified as follows:**<br>• Bridges with intermediate supports<br>eg. 1. Crates 2. Cribs 3. Pile bents 4. Trestles.<br>• Bridges without intermediate supports<br>eg. 1. Cantilevers 2. Suspension bridges 3. Trusses.<br>• Floating bridges<br>eg. 1. Boat bridges 2. Pontoon bridges 3. Raft bridge. | **1**<br>**1 each (any two)**<br>**½ each (any two)** | **4** |
| | f) Ans. | **State the situations where following types of foundation is provided. (i) Well foundation (ii) Pile foundation.**<br>**(i) Well foundation:**<br>1. It is provided in under water construction when depth of water is considerable but a firm ground rocky strata is available immediately below the river<br>2. Well foundation is provided where the soil stratum comprises of sand or stiff clay. | **2** | |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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| Q.4 | f) | **(ii) Pile foundation:**<br>1. Where soil is very soft and hard bed is not available at a reasonable depth<br>2. Where it is expensive to provide raft or grillage foundation<br>3. Where heavy scouring of river bed is expected<br>4. When a building has very heavy, concentrated loads, such as in a high rise structure, bridge, or water tank. | **2** | **4** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
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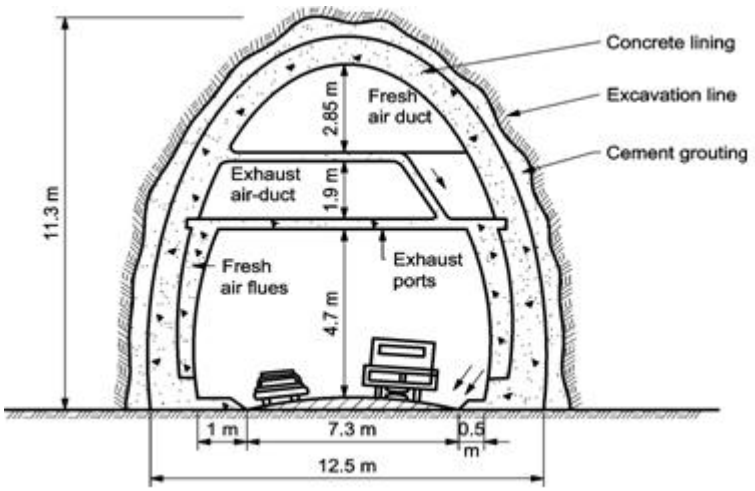
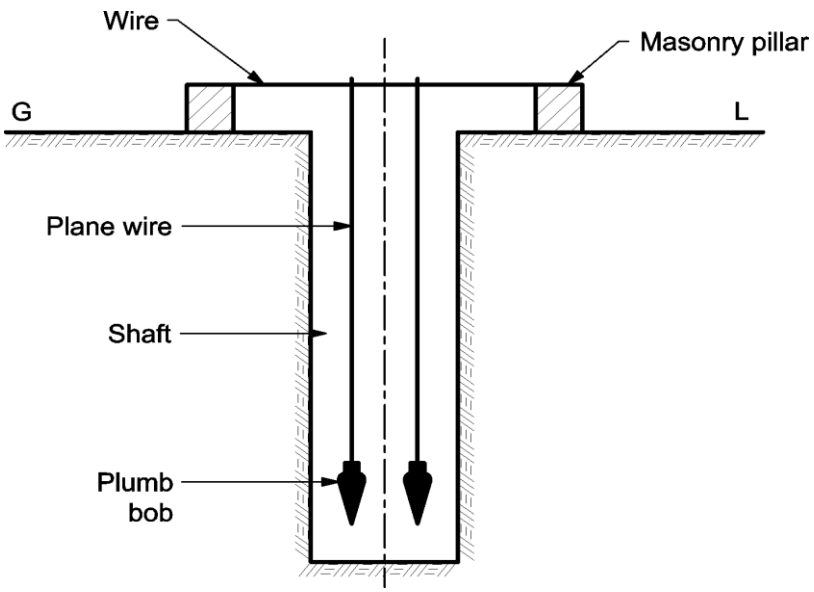
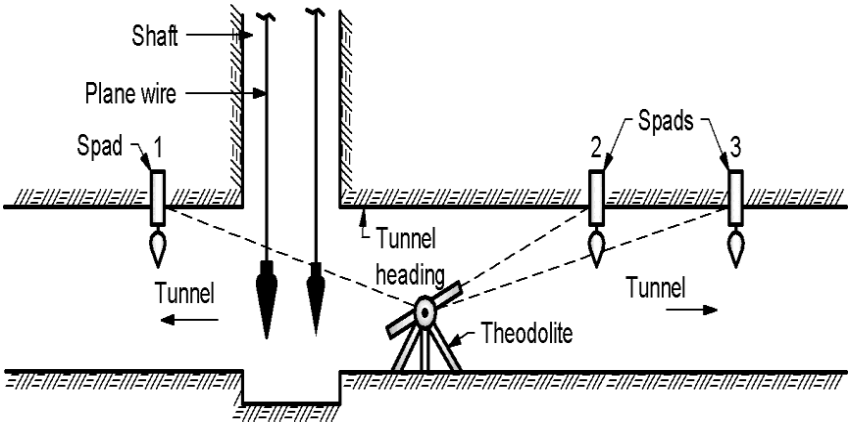
| **Q.5** | | **Attempt any <u>FOUR</u> of the following:** | | **16** |
| | **a)** | **Describe in brief maintenance of bridges.** | | |
| | **Ans.** | The art of keeping the bridge components in good condition to keep the bridges in best serviceable order for a longer period is known as bridge maintenance or maintenance of bridges. | **2** | |
| | | **Necessity of bridge maintenance:** | | |
| | | 1. After the bridge is constructed and opened to traffic, its components such as foundations, pier, abutments, wing walls, approaches, flooring system, railing etc. are subjected to damages due to so many reasons. Therefore it is necessary to maintain bridge in such condition that it functions properly. | **2** | **4** |
| | | 2. Maintenance of bridge becomes essential to keep them in best serviceable condition for a longer period. | | |
| | **b)** | **Describe in brief inspection of bridge.** | | |
| | **Ans.** | The following points should be kept in view while inspecting a bridge;<br>1. Condition of wearing coat and its thickness.<br>2. Condition of kerbs and railings.<br>3. Condition of expansion joints, whether functioning well or not in case of concrete bridge.<br>4. Condition of concrete, whether in good condition or spalling in case of concrete bridge.<br>5. Condition of reinforcement, whether exposed anywhere or not in case of concrete bridge.<br>6. Condition of paint in case of steel and iron bridge.<br>7. Condition of steel work, material, members and connections in case of steel or iron bridge.<br>8. Condition of material used in arches in case of arch bridge.<br>9. Condition of masonry, whether good or weathered.<br>10. Condition of mortar joints in case of masonry arch bridge.<br>11. Condition of bearings, whether functioning properly.<br>12. Any sign of development of cracks in masonry or concrete immediately below the bearings.<br>13. Condition of abutments, piers and wing walls, whether good weathered or bulged.<br>14. Any sign of development of cracks in concrete abutments and piers.<br>15. Any sign of settlement of foundation.<br>16. Any sign of scour along with maximum depth of scour. | **½ each (any eight)** | **4** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
|---|---|---|---|---|
| Q.5 | c) Ans. | **State the necessity of providing tunnel.**<br>**The necessity of providing tunnel:**<br>1. To provide passage for railway track.<br>2. To provide passage for roads.<br>3. To provide access to mines.<br>4. To lay conduits for water etc.<br>5. They connect the terminal stations by the shortest route and thus results in less transportation cost.<br>6. They help on avoiding holding-up of traffic for long periods due to traffic congestion and provide rapid transportation.<br>7. They help in avoiding acquisition of costly and valuable land property for transportation projects. | **1 each (any four)** | **4** |
| | d) Ans. | **State advantages and disadvantages of tunnel.**<br>**Advantages:**<br>1. It connects the two terminal stations by the shortest route.<br>2. They facilitate less route length and thus results in less transportation cost.<br>3. It carries railway lines, roads and public utilities like water, oil, gas etc. across a stream or mountain.<br>4. It helps in avoiding acquisition of costly valuable land and property for road or railway projects.<br>5. It eliminates excessive cost of maintenance of an open cut subjected to land slide.<br>6. It provides free movement of traffic throughout the year even during snowfall and land slide.<br>7. It facilitates conduction of water to generate power.<br>**Disadvantages:**<br>1. It requires special equipment and method for their construction.<br>2. It require more time for construction.<br>3. It requires supervision and skilled labour for construction.<br>4. It may cause suffocation if not properly ventilated. | **1 each (any two)**<br>**1 each (any two)** | **4** |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
|---|---|---|---|---|
| Q.5 | e) Ans. | **Draw a neat sketch of tunnel for a national highway showing its components and dimensions.**<br>  <br><br>**Fig. :Cross Section of Tunnel for a National Highway**<br><br>***(Note: 2 marks for figure, 2 marks for labelling and dimensions.)*** | **4** | **4** |
| | f) Ans. | **Describe in brief transferring of center line in inside the tunnel with neat sketch.**<br>First of all shaft is constructed. After construction of shafts, the center line of tunnel is to be transferred down the shafts. For this purpose, generally two small pillars are constructed on opposite edges of the shaft along the center line of the tunnel. On the top of pillars, the points corresponding to the centre line are correctly marked and a wire is then stretched between them. After this two plumb bob are suspended by piano wire inside the shaft as shown in figure above. Two points are then marked by lowering plumb bob to the bottom of the shaft. The line joining the two points represents the center line of the tunnel marked on the ground. These lines are further extended into the tunnel heading as the work advances, by a theodolite placed in the shafts. Points along the centre line are marked by a peg provided with plumb bobs, fixed to the roof of the tunnel as shown in figure below. | **2** | |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
|---|---|---|---|---|
| Q.5 | f) |  **Fig. :Transferring Alignment at the Bottom of the Shaft**  **Fig. :Transferring Alignment Inside Tunnel** | 2 | 4 |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
|---|---|---|---|---|
| **Q.6** | | **Attempt any FOUR of the following:** | | **16** |
| | **a)** | **State any four purposes of providing shafts.** | | |
| | **Ans.** | **The purposes of providing shafts in tunnel are as follows:**<br>1. To provide opening for removal of muck.<br>2. To expedite the construction work of the tunnel by starting excavation at several points at the same time.<br>3. To provide passageway for pumping out the water from the tunnel.<br>4. To provide natural ventilation during construction of the tunnel. | **1 each** | **4** |
| | **b)** | **Enlist the different methods used in tunneling in hard rock and soft rock.** | | |
| | **Ans.** | **Method of tunneling in hard rock:**<br>1. Full – face heading method<br>2. Heading and bench method<br>3. Drift method<br>**Method of tunneling in soft rock:**<br>1. Needle beam method<br>2. Fore poling method<br>3. Linear plate method<br>4. Shield method<br>5. American method<br>6. English Method | **1 each (any two)**<br><br>**1 each (any two)** | **4** |
| | **c)** | **State advantages and disadvantages of needle beam method.** | | |
| | **Ans.** | **Advantages:**<br>1. This method is economical<br>2. Brick lining can be easily done by this method.<br>**Disadvantages:**<br>1. Concrete lining by mechanical method is difficult.<br>2. Pushing of beam by hand is difficult.<br>3. It requires large number of french jacks and the interfere with the efficient working of the labour gang | **1 each (any two)**<br><br>**1 each (any two)** | **4** |
| | **d)** | **State precautions to be taken during construction of tunnels.** | | |
| | **Ans.** | 1. Depending on the purpose of tunnel shape should be decided<br>2. Cross - sectional dimensions of the tunnel should be decided to achieve economy in its construction.<br>3. In order to make proper use of labour and equipment, sequence of operation must be well planned previously. | | |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
|---|---|---|---|---|
| **Q.6** | **d)** | 4. Labour should be well organized to maintain continuous progress of the tunneling operations.<br>5. The use of outdated and unsuitable tools must be avoided.<br>6. Each and every operation must be completed in scheduled time as far as possible.<br>7. Loading and hauling of muck should be carried out efficiently. In order to achieve economy, the sequence and type of lining should be determined in advance.<br>8. Selection of multipurpose and uniform type of equipment should be made, according to the size and shape of the tunnel.<br>9. Pattern of blasting the material in different locations should be decided for maintaining speed of driving and safety. | **1 each (any four)** | **4** |
| | **e)** | **State the necessity of providing tunnel lining.** | | |
| | **Ans.** | **Necessity of providing tunnel lining.**<br>1. To provide the correct, desired shape to the tunnel.<br>2. To support the loosened rock pieces during blasting.<br>3. To increase the structural strength of soft places in the tunnel.<br>4. To improve the appearance of tunnel.<br>5. To prevent percolation of water inside the tunnel.<br>6. To reduce the maintenance cost of tunnel.<br>7. To house electrical fitting.<br>8. To withstand soil pressure when driven in soft rocks. | **1 each (any four)** | **4** |
| | **f)** | Discuss the different methods used for tunnel ventilation. | | |
| | **Ans.** | Methods of ventilation of tunnel are as follows:<br>1. Natural method<br>2. Mechanical method<br>**1. Natural method:**<br>• Natural ventilation is possible automatically due to difference of temperature inside and outside the tunnels.<br>• Good ventilation is not possible by this method.<br>• Natural ventilation can be improved by providing shafts at a suitable interval along the alignment of a tunnel during its construction.<br>This method is suitable when :<br>(a) Tunnel is to be laid in the direction of wind.<br>(b) A drift is driven from portal to portal.<br>(c) Diameter of the tunnel is large but its length is small.<br>**2. Mechanical method:**<br>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 | **2** | |

| Que. No. | Sub. Que. | Model Answers | Marks | Total Marks |
|---|---|---|---|---|
| Q.6 | f) | below.<br>1. Blowing process<br>2. Exhausting process<br>3. Combination of blowing and exhausting<br>**1) Blowing process:**<br>• In this method of mechanical ventilation, fresh air is forced by on e or two blowers through the ducts, provided in the tunnel.<br>• By this method, positive supply of fresh air at the working place can be obtained.<br>• 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.<br>• This method is also known as propulsion method.<br>**2) Exhausting process:**<br>• In this method of mechanical ventilation, air is sucked by one or two exhaust fans installed near the tunnel heading.<br>• This creates vacuum due to which fresh air enters inside the tunnel.<br>• This method has the special advantage of quick removal of dust and smoke from the working face.<br>• This method is also known as vacuum method.<br>**3) Combination of blowing and exhausting process:**<br>• In this method, blower and exhaust fans are provided for forcing fresh air in the tunnel and sucking foul air from the tunnel.<br>• The blower and exhaust fans are installed in suitably spaced inlet and outlet shafts connected to the tunnel.<br>• Immediately after the blasting operation, the exhausting system is operated for 15 to 30 minutes, to remove the objectionable air.<br>• After which blowing system is operated for forcing fresh air in the tunnel.<br>• This method provides the most efficient ventilation system of tunnels. | **2** | **4** |