



SUMMER– 18 EXAMINATION

Subject Name: HIGHWAY ENGINEERING

Model Answer

Subject Code:

17602

Important Instructions to examiners:

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

Q. No.	Sub Q. N.	Answers	Marking Scheme
Q.1	A) (a) Ans	<i>Attempt any THREE</i> <i>Write the classification of roads according to :</i> <i>(i) Nagpur road development plan</i> <i>(ii) Third road development plan</i> (i) Nagpur road development plan:- i) National Highway (NH) ii) State Highway (SH) iii) Major District Roads (MDR) iv) Other District Road (ODR) v) Village Road (VR) (ii) Third road development plan:- a) Primary System i) Expressway ii) National Highway b) Secondary System i) State Highway ii) Major District Road c) Tertiary System i) Other District Road ii) Village Road	02 M 02 M
Q.1	A)(b) Ans	<i>Write the names of four modes of transportation. Write the medium used in each mode of transportation.</i> Modes of Transportation:- i) Roadway Transportation: - Medium used is land. ii) Railway Transportation: - Medium used is land. iii) Waterway Transportation: - Medium used is water. iv) Airway Transportation:- Medium used is air.	01 M each
Q.1	A)(c)	<i>Explain in brief any two surveys conducted before road construction.</i>	



Ans		<p>Different types of surveys conducted before road constructions are:</p> <p>i) Reconnaissance survey: - A field survey which examines the general character of a land between the terminals stations in the field along the proposed alternative alignments marked on the map is known as reconnaissance survey.</p> <p>Object of Reconnaissance Survey-</p> <p>a) To collect the details of terrain soil conditions, geology of Area, nature of soil, drainage condition and nature of hill slopes.</p> <p>b) To locate the obligatory points along the alternative routes.</p> <p>c) To determine approximate estimate of the total cost of construction.</p> <p>d) To determine two or three best possible routes.</p> <p>ii) Preliminary survey:- The art of finding the details of alternative alignments found suitable during the reconnaissance survey is known as preliminary survey.</p> <p>Object of Preliminary Survey-</p> <p>a) To survey along the various alternate alignments found suitable during the reconnaissance survey and to collect all necessary details.</p> <p>b) To compare the different proposals in view of the requirements of a good alignment of the Road.</p> <p>c) To estimate quantity of earthwork materials and other construction aspects and to work out the cost of alternate proposals.</p> <p>d) To finalize the best alignment from all considerations.</p> <p>iii) Location survey:- The detailed examination of the field along the alignment finally recommended during the preliminary survey is called location survey.</p> <p>Object of Location Survey-</p> <p>a) To collect the data necessary for the acquisition of right of way.</p> <p>b) To fix up the center line of the proposed road on the ground.</p> <p>c) To determine the cost of the road project.</p> <p>d) To collect data which is required for drafting of specifications, preparation of detailed drawing for working out items and quantities</p>	Any two 02 M for each
Q.1	A)(d) Ans	<p>State the names of any four drawings & use of each drawing required for road construction.</p> <p>The various drawings prepared for a highway project are as follows:</p> <ol style="list-style-type: none">1. Key map :- It shows the proposed road, existing roads and important places to be connected2. Index map:-It shows the location of the road with respect to important towns, industrial centers,3. Preliminary survey plan:-These plans show the details of the various alternate alignments and other information collected during preliminary survey.4. Detail location survey plan and longitudinal section: - It shows the ground plan along with alignment of the road. It also shows all existing structure, river and other natural details, physical features etc.5. Detail cross section of road: - These cross section drawings show the cutting and filling at the different reduced distance along the center line of the road. This cross section helps in finding the quantity of earthwork.6. Land acquisition plans: - These shows all general details such as buildings, wells, nature of land and other details required for assessing the values.7. Drawings of cross drainage and masonry structures: - In this type, drawings of road intersections should be prepared showing all details of pavement.	Any four 01 M for each

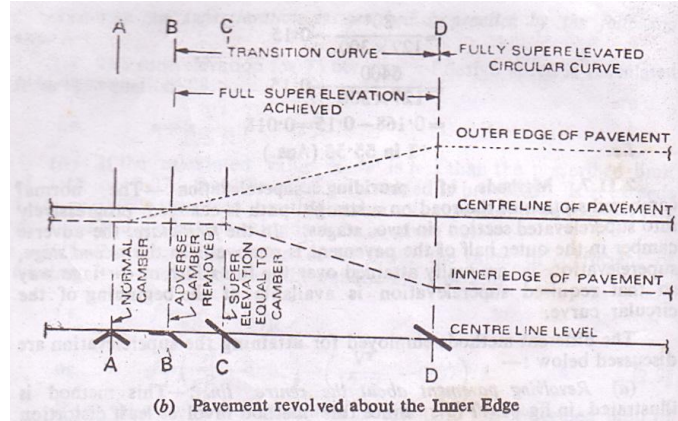
Q.1	A)(e) Ans	<p>Define: (i) Right of way (ii) Reaction time (iii) Distance kerb (iv) Passing sight i. Right of way:-The area of the land acquired for construction and development of a road along its alignment is known as right of way. ii. Reaction time: - The time taken by the driver from the instant the object is visible to the driver to the instant the brakes are effectively applied is known as reaction time of the driver. iii. Kerb: - The distance between the pavement and shoulders or footpaths are known as distance kerb. iv. Passing sight distance:- The minimum distance open to the vision of the driver on a two way road to enable him to overtake another vehicle ahead with safely against the traffic from opposite direction is known as passing sight. Note: - There are no terms like distance kerb and passing sight. In place of that kerb and passing sight distance are required.</p>	01 M for each
Q.1	B) (a) Ans	<p>Attempt any ONE: For a national highway the allowable speed is 60 kmph. If the radius of curvature of road is 300 m, calculate the super elevation to be provided for the road. Take co-efficient of friction = 0.15. By formula of super elevation, $e + f = \frac{V^2}{127 \times R}$ $e + 0.15 = \frac{60^2}{127 \times 300}$ $e + 0.15 = 0.094$ $e = - 0.056$ Super elevation required is negative, hence no need to provide super elevation.</p>	02 M 02 M 02 M
Q.1	B)(b) Ans	<p>Draw a c/s of national highway in embankment.</p> <p style="text-align: center;">CROSS-SECTION OF A NATIONAL HIGHWAY (N.H) IN EMBANKMENT</p>	02 M for figure 02 M for labeling 02 M for dimension s
Q.2	(a) Ans	<p>Attempt any FOUR: What is location survey? Which information is collected in location survey? Location survey: The detailed examination of the field along the alignment finally recommended during the preliminary survey is called location survey. The following information is collected in Location Survey-</p> <ol style="list-style-type: none"> To collect the data necessary for the acquisition of right of way. To fix up the center line of the proposed road on the ground. To determine the cost of the road project. 	02 M 02 M



		d) To collect data which is required for drafting of specifications, preparation of detailed drawing for working out items and quantities.	
Q.2	(b) Ans	What is road alignment? State the factors affecting road alignment. Road Alignment: It is the center line of proposed road marked in plan, which is known as road alignment. Factors affecting road alignment : 1. Unavoidable obstructions: The alignment is required to change in another direction due to avoidable obstructions. 2. Connectivity of obligatory points : The selected alignment can be altered for better connectivity to existing roads, important places and high population zone 3. Railway or Bridge crossing: The alignment is necessary to divert over railway or bridge crossing at right angle. 4. Nature of ground : If ground is more steeper then alignment is required to change towards fairly leveled ground 5. Type of foundation soil: If foundation soil available in the proposed alignment has less bearing capacity, then alignment is changed through hard subgrade soil. 6. Cost of land: If cost of land in particular alignment more, it is necessary to pass it through less costlier land. 7. Excessive cutting of rock: The alignment should be such that to avoid excessive cutting of hill rocks coming in alignment. 8. Locally available materials: The alignment should be finalized to get continuous and maximum availability of materials required for road construction.	01 M Any three 01 M for each
Q.2	(c) Ans	What is design speed? State the factors affecting design speed. Design speed: - The maximum safe speed of vehicles assumed for geometrical design of a highway is known as design speed. Factors affecting design speed:- a) Class and condition of the road surface. b) Nature, intensity and type of traffic. c) Type of curve along the road. d) Sight distance required. e) Nature of terrain. f) Structure of the road.	01 M 1/2 M for each
Q.2	(d) Ans	Which points should be kept in view during geometric design of roads? The following points should be kept in view during geometric design of road: 1) The alignment should be economical. 2) The gradient must be easy and suitable. 3) On straight road, provide adequate camber. 4) Curves provided must be smooth and easy. At the same time sufficient sight distance must be available on curves. 5) Proper road signals must be provided. 6) At the same time, keep in view the estimated cost of project.	Any four 01 M for each
Q.2	(e) Ans	What is surface dressing? State its procedure. Surface dressing: The method of applying one or two coats of bituminous material, each consisting of a layer of bituminous binder sprayed on the prepared base, followed by a cover of stone chippings properly rolled to form a wearing course is known as surface dressing. Procedure:	02 M

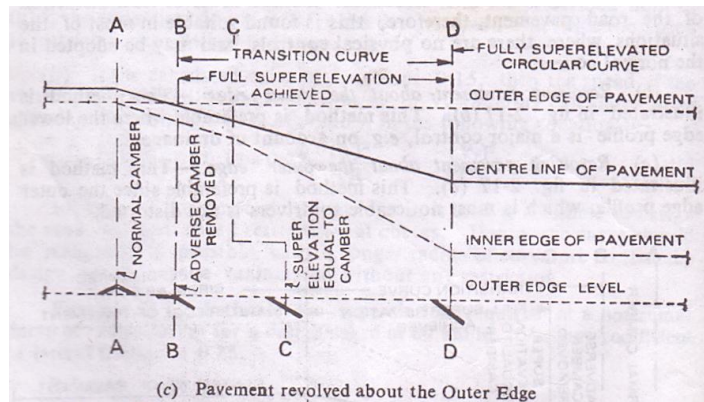
		<ol style="list-style-type: none"> 1) Preparation of existing surface. 2) Application of binder. 3) Application of stone chippings. 4) Rolling of first or final coat. 5) Application of binder and stone chippings for second coat. 6) Rolling of second coat. 7) Finishing and opening to traffic. 	02 M
Q.2	(f) Ans	<p>State the use of the following concrete road equipment :</p> <p>(i) Template (ii) Float (iii) Screw (iv) Edge plate</p> <p>(i) Template: - It is used for checking contour of the subgrade. (ii) Float: - It is used to level the concrete surface. (iii) Screw:- It is used for tightening the edge plate. (iv) Edge plate: - It is used to support concrete to achieve required thickness.</p>	01 M for each
Q.3	(a) Ans	<p>Attempt any FOUR:</p> <p>What is super elevation? State the methods of providing super elevation.</p> <p>Super elevation: The inward transverse inclination provided to the cross section of the carriageway at horizontal curved portion of a road is called super elevation, cant or banking.</p> <div data-bbox="516 1010 1019 1276" data-label="Image"> </div> <p>Method of providing super elevation: The different methods employed for attaining the super elevation are as follows:</p> <ol style="list-style-type: none"> i. Revolving pavement about the centre line. ii. Revolving pavement about the inner edge. iii. Revolving pavement about the outer edge. <p>(i) Revolving pavement about the centre line :</p> <div data-bbox="540 1560 1222 1990" data-label="Diagram"> </div>	01 M

(ii) Revolving pavement about the inner edge :



01 M

(iii) Revolving pavement about the outer edge :



01 M

Q.3
Ans

Define camber. State the factors to be considered while providing camber for a road.
Camber :

The convexity provided to the surface of carriage way or the rise given to the centre of carriage way above its edges on straight portion of a road is called camber or cross fall.

The factors to be considered while providing camber for a road are as follows:

- (1) **Intensity of rainfall:** The amount of road camber depends on the intensity of rainfall in the locality.
- (2) **Road surfacing material:** The amount of road camber also depends on the permeability of the road surfacing material.

02 M

02 M
(01 M for each)

Q.3
Ans

Define:
(i) lead (ii) lift (iii) borrow pit (iv) spoil bank

(i) Lead : The horizontal distance through which the excavated earth is carried and placed for constructing the bank is called lead.

(ii) Lift : The vertical distance through which the excavated earth is lifted for constructing a bank is called lift.

(iii) Borrow pit : The pit dug along the alignment of a road for using their material in the construction of road embankment is known as borrow pit.

(iv) Spoil bank : The bank constructed from surplus excavated earth on the side of cutting parallel to the alignment of the road is known as spoil bank.

04 M
(01 M for each)



Q.3
(d)

State the functions of:
(i) catch water drain (ii) breast wall (iii) retaining wall & (iv) 'cross drain in case of hill roads





	Ans	<p>The functions of catch water drain, breast wall, retaining wall and cross drain in case of hill roads are as follow:</p> <p>(i) Catch water drain : The function of this drain is to intercept the run off from the hill slope which would otherwise rush on to the road and wash it away and then to divert the same into a nearby cross drainage work.</p> <p>(ii) Breast wall : The function of breast wall is to prevent the hill side from sliding down.</p> <p>(iii) Retaining wall : The function of retaining wall is to resist the pressure of earth filling and traffic load coming on the road.</p> <p>(iv) Cross Drain : the function of cross drains is to drain off the rain water across the road.</p>	04 M (01 M for each)																								
Q.3	(e) Ans	<p>Write the names of four road construction materials. Write their source & use.</p> <p>The following are the road construction materials with their source and use.</p> <table border="1" data-bbox="253 617 1409 1396"> <thead> <tr> <th>Sr. no.</th> <th>Road materials</th> <th>source</th> <th>Use</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Soil</td> <td>Earth crust</td> <td>It is use as foundation of road pavement as well as in various courses/layer of road pavement.</td> </tr> <tr> <td>2</td> <td>Aggregates (fine and course)</td> <td>Crusher plant and River or earth crust</td> <td>It is used for constructing pavements in cement concrete, bituminous concrete and other bituminous constructions. It is also used as granular base course underlying the superior pavements.</td> </tr> <tr> <td>3</td> <td>Cement</td> <td>Cement manufacturing plant</td> <td>It is used as a binding material in the concrete road pavements and also as a stabilizer for constructing stabilized earth roads.</td> </tr> <tr> <td>4</td> <td>Bitumen</td> <td>Petroleum plant</td> <td>It is used as a binding material in bituminous road pavements and also as a stabilizer for constructing stabilized earth roads.</td> </tr> <tr> <td>5</td> <td>Steel bars or Reinforcement</td> <td>Steel bars manufacturing plant</td> <td>It is used as reinforcement or tie bars, dowel bars in Rigid pavement.</td> </tr> </tbody> </table>	Sr. no.	Road materials	source	Use	1	Soil	Earth crust	It is use as foundation of road pavement as well as in various courses/layer of road pavement.	2	Aggregates (fine and course)	Crusher plant and River or earth crust	It is used for constructing pavements in cement concrete, bituminous concrete and other bituminous constructions. It is also used as granular base course underlying the superior pavements.	3	Cement	Cement manufacturing plant	It is used as a binding material in the concrete road pavements and also as a stabilizer for constructing stabilized earth roads.	4	Bitumen	Petroleum plant	It is used as a binding material in bituminous road pavements and also as a stabilizer for constructing stabilized earth roads.	5	Steel bars or Reinforcement	Steel bars manufacturing plant	It is used as reinforcement or tie bars, dowel bars in Rigid pavement.	Any four 01 M for each
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Q.4	(A) (a) Ans	<p>Attempt any THREE.</p> <p>Write the construction procedure of WBM road.</p> <p>The construction of a WBM road is completed in the following stages:</p> <ol style="list-style-type: none"> <u>Preparation of subgrade</u> : The subgrade is prepared to the required grade and camber. <u>Preparation of the base course</u> : After preparing the subgrade or sub base, the required type of base course is constructed with specified materials in conformity with lines, grade and thickness. <u>Preparation of intermediate and wearing course</u>: The preparation of intermediate and wearing course of a WBM road is done in following steps: <ul style="list-style-type: none"> (i) <u>Preparing the surface</u> :- The surface of the newly laid base course on which some traffic has been allowed, is checked and the defective portions are rectified. (ii) <u>Providing edging or earthen kerbs</u> :- After preparing the surface brick-on-end edging is provided along the outer edges of the carriage way of the road. (iii) <u>Spreading of coarse aggregate</u> :- The road metal is spread evenly over the prepared base to the specified thickness. 	01 M																								



		<p>(iv) <u>Dry rolling</u> :- After spreading the course aggregate, dry rolling is done by means of a suitable roller. The rolling should be started from edges and gradually shifted towards the centre after properly rolling each strip.</p> <p>(v) <u>Spreading of screenings</u> :- After dry rolling, a blindage layer consisting of stone screenings (12 mm grits) is spread at a slow and uniform rate so as to ensure filling of all voids.</p> <p>(vi) <u>Wet rolling</u> :- After spreading the screenings, the surface is sprinkled over with sufficient quantity of water, swept and rolled.</p> <p>(vii) <u>Application of binding material, watering and rolling</u> :- After the application of screening and wet rolling, the binding material is applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface is freely sprinkled with water and rolled with 6 to 10 tonne roller.</p> <p>(viii) <u>Finishing the surface</u> :- After the final compaction, road surface is allowed to dry overnight.</p> <p>(ix) <u>Setting and drying</u> :- The surface is then allowed to cure for 7 to 9 days.</p> <p>4. <u>Preparation of shoulders</u> : During curing, the shoulders are prepared by filling earth to the specified cross slope. These are then properly compacted by rolling or tamping.</p> <p>5. <u>Open to traffic</u> : After drying, the road is opened to traffic.</p>	02 M
Q.4	(A) (b) Ans	<p>What are the traffic islands? How they help in controlling traffic?</p> <p>Traffic islands: The raised platforms of suitable shapes built on the road intersections are called traffic islands.</p> <p>The traffic islands help in controlling traffic in following manner: Due to traffic islands vehicles from the converging arms are forced to move round a central island in one direction (always clock wise direction) in an orderly and organized manner and weave out of the rotary movement into their desired direction. Thus, it avoids traffic congestion and provide efficient, free and rapid flow of all types of traffic on road intersection.</p>	02 M 02 M
Q.4	(A) (c) Ans	<p>Draw sketches of the following road signs: (i) No entry (ii) Speed breaker - (iii) Refreshment place (iv) Overtaking prohibited</p> <p>(i) No Entry:-</p>  <p>(ii) Speed Breaker:-</p> 	01 M for each



		<p>(iii) Refreshment place :-</p>  <p>(iv) Overtaking Prohibited :-</p> 	
Q.4	(A) (d) Ans	<p>Write the remedial measures in case of the following road defects :</p> <p>(i) Formation of ruts in case of earthen roads. (ii) Formation of pot holes in case of WBM roads. " (iii) Bitumen bleeding in case of bituminous roads. (iv) Development of cracks in case of concrete roads.</p> <p>The remedial measures in case of the following road defects are as follows:</p> <p>(i) <u>Formation of ruts in case of earthen roads</u> : The remedial measure is quite simple.</p> <ol style="list-style-type: none"> (1) Cleaning the affected area and light watering. (2) Filling the rut using selected earth. (3) watering and compaction by rolling. (4) checking of camber for efficient drainage. <p>(ii) <u>Formation of pot holes in case of WBM roads</u> : The pot holes should be patched up.</p> <ol style="list-style-type: none"> (1) Cutting the defective area to rectangular shape and removing the loose stones up to the affected depth. (2) Filling up the prepared area with coarse aggregate of the same size. (3) Watering and compaction by rammer or road roller. (4) Application of wet soil binder to fill up the interstices and compaction. <p>(iii) <u>Bitumen bleeding in case of the bituminous roads</u> : If the surfacing consists of excessive bitumen, the surface become slippery during rainy season and bleed during hot weather. Bleeding normally occurs just after the construction of the road. For bleeding the Surface treatment is remedy. Bleeding can easily be corrected by spreading a layer of dry coarse sand in a thickness varying 5 mm to 10 mm and rolling the surface.</p> <p>(iv) <u>Development of cracks in case of concrete roads</u> : The remedial measure for this defects is as follow:</p> <ol style="list-style-type: none"> (1) The crack is thoroughly cleaned by mean of a suitable sharp pointed tool and then dirt is blown off by a blower. (2) The surface of the crack is then coated with kerosene oil to facilitate the adhesion of the sealing material with the old concrete. 	<p>01 M</p> <p>01 M</p> <p>01 M</p> <p>01 M</p>



		(3) The crack is then filled with a molten sealing compound. (4) The repair of the cracks should be done during summer season before monsoon.	
Q.4	(B) (a)	Attempt any ONE. What is soil stabilization? State its necessity. Explain any two methods of soil stabilization.	
Ans		<p><u>Soil stabilization</u> : The process of improving stability or bearing power of the ordinary soil by the use of controlled compaction, proportioning and adding of suitable stabilizers is known as soil stabilization.</p> <p>* <u>Necessity of soil stabilization</u> : The soil stabilization is necessary</p> <p>(1) To increase the bearing power of the soil. (2) To increase resistance to softening action (due to water) of the soil. (3) To increase shear strength i.e. resistance to punching action of the soil. (4) To increase flexibility in the soil to take the wheel load without deformation and cracking. (5) To reduce the tendency of swelling or increase in volume of the soil due to wetting and shrinkage on account of withdrawal of moisture. (6) To increase the stability of earthwork in embankment as a whole.</p> <p>* Methods of soil stabilization : Following are the methods of soil stabilization:</p> <p>1. <u>Mechanical Stabilization</u> : In this method the soil is tested. If the soil is coarse grained, fine grained soil is so added that the proportion of coarse and fine grains is 2 and similarly, if the soil is sandy, requisite quantity of clay is added to adjust the proportion. The soil is ploughed to a depth of nearly 15 cm, and pulverized; and then the required quantity of fine or coarse grains is added. After sprinkling water the surface is compacted by light rollers and then to be cured for about 4 to 5 days.</p> <p>2. <u>Cement Stabilization</u>: Cement is a binding material. When mixed with soil, it forms a sort of low strength concrete in which the soil acts as aggregate and cement as matrix. So the soil is excavated to a depth of nearly 15 cm and 8% to 12% of cement is mixed. Sufficient quantity of water is then added and the soil cement mixture is compacted properly by road stabilizers. After it has been compacted it is then cured for about 7 to 8 days by simply sprinkling water over it.</p> <p>3. <u>Lime Stabilization</u>: In this case the process of stabilization is similar to that of cement stabilization. The soil loosened, pulverized, sieved and mixed with 5 to 10% by weight of hydrated lime. The two are thoroughly mixed. Sufficient quantity of water is added and the surface is compacted. The lime helps in reducing the shrinkage and swelling of soil.</p> <p>4. <u>Bitumen Stabilization</u>: In this method the soil is treated with about 8 to 10% of road oils, cut backs or emulsion, according to the nature of the soil. Their object is to glue together the soil particles and fill up the voids.</p> <p>5. <u>Chemical Stabilization</u>: Hygroscopic materials such as calcium chloride, sodium chloride etc. are mixed with the soil at the rate of 1 kg per 5 sq. m. of the surface and the soil is thoroughly compacted. These hygroscopic materials help in retaining proper amount of moisture in the soil and add to its stability.</p> <p>6. <u>Grouting</u>: Grouting or injecting is a process of introducing a stabilizer of fluid consistency into soil and rock formations. The stabilizer used is known as grout. The usual grouting materials are cement, soil, bitumen and chemicals. Holes are driven at regular intervals and of desired depth and the grouting material of fluid consistency is injected under heavy pressure with the help of a grouting pump. The grout having the</p>	02 M 02 M (Any four 1/2 M for each) 02 M (Any Two methods 01 M for each)



cementing properties will bind the soil particles.

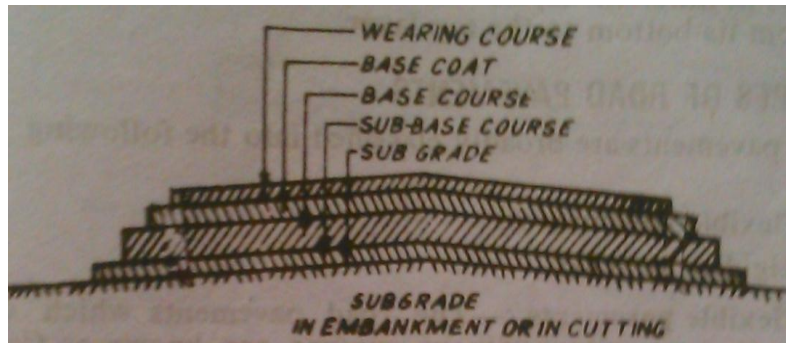
7. Electrical Stabilization: Electrical stabilization is a method of drawing out the fine-grained soil by passing direct current through them. It is also sometimes called Electro-osmosis. With the damage of the fine particles the volume of the soil decreases i.e. the soil is consolidated and the shear strength is increased. This will ultimately lead to hardening of soil and process is sometimes known as electro-chemical hardening.

8. Complex stabilization: Complex stabilization is defined as the method of stabilization with more than one stabilizer. Difficult soils such as organic soils, highly plastic for clays and soils with easy-soluble salts, require more than one stabilizer for their effective treatment. Complex stabilization involves the use of binding material and surface acting additives or electrolytes.

Q.4 (B)(b)
Ans

Draw a c/s of pavement structure. Write the function of each component of pavement structure.

The cross section of pavement structure is as shown below:



Cross section of road pavement structure

- The functions of each component of pavement structure are as follows:

(1) Function of Subgrade :

- (i) To bear ultimately the entire load of pavement including the load of traffic transmitted through the pavement.
- (ii) To provide an adequate and uniform support to the road pavement.

(2) Function of Sub-base :

- (i) To improve the bearing capacity of the subgrade.
- (ii) To improve drainage and to check capillary rise of sub-soil water.
- (iii) To eliminate frost heave in frost affected area.
- (iv) To prevent subgrade material from working up into the base course.

(3) Function of Base course :

- (i) To withstand high shearing stresses imposed upon it due to impact of traffic on the wearing course.
- (ii) To act as foundation for the road pavement and to transfer the wheel loads coming over the pavement surface safely to the sub-base and subgrade lying underneath.

(4) Function of Base coat :

- (i) To transmit wheel loads coming on the pavement surface over larger area of the base course.
- (ii) To act as a layer of transmission material since, otherwise, there is great difference in size of aggregates used in wearing course and base course.

(5) Function of Wearing course :

- (i) To distribute the traffic load safely to the base course.

02 M
(for neat labeled diagram)

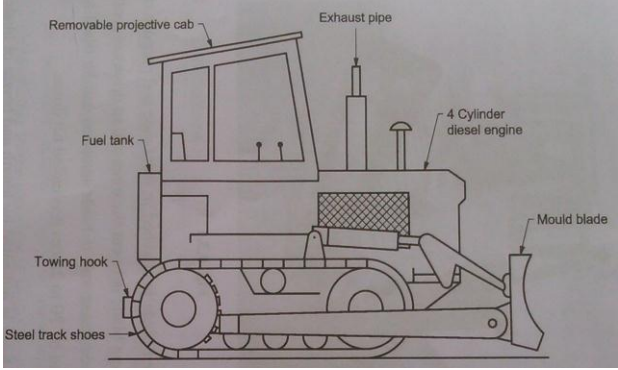
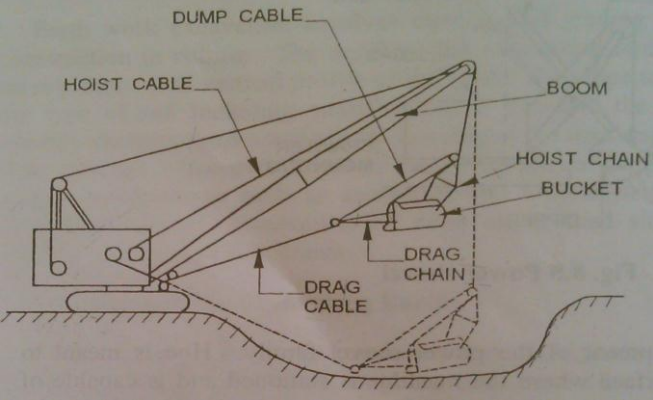
04 M
(Any four with two function in each. 01 M for each)



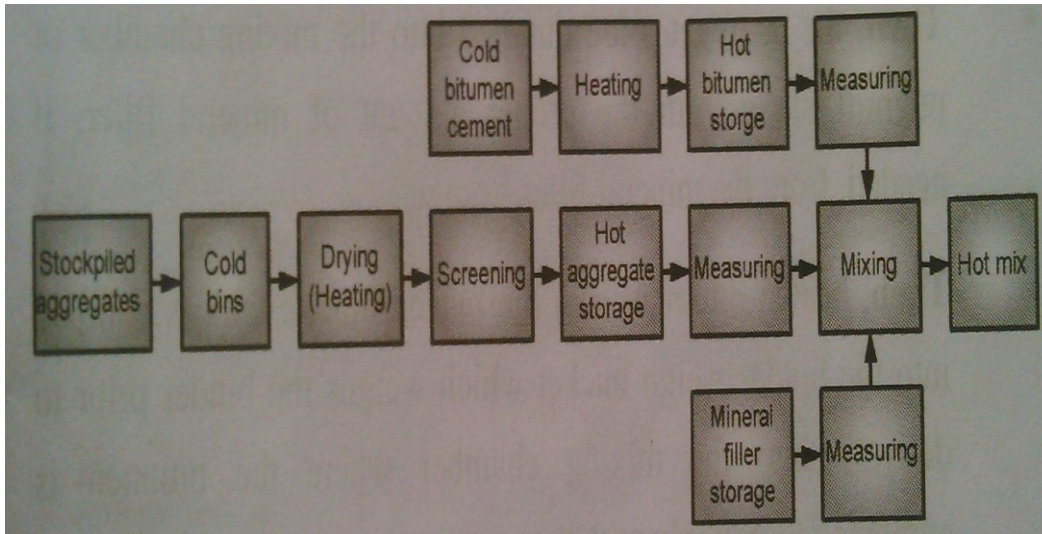
		<p>(ii) To act as an impervious layer so that the surface water may find its access to the base course.</p> <p>(iii) To prevent dust nuisance.</p> <p>(iv) To withstand abrasion caused due to movement of traffic.</p> <p>(v) To provide a smooth riding surface.</p>	
Q.5	(a) Ans	<p>Attempt any FOUR</p> <p>What are road markings? State its types.</p> <p>Road markings : The lines, patterns, words, symbols or reflectors applied to the carriage way, kerbs, sides of islands or to fixed objects near the roadway are known as traffic or road markings.</p> <p>Types of road markings: Various types of road markings are classified as given below:</p> <p>(1) <u>Carriage way markings</u> – longitudinal markings such as centre line, traffic lanes, border or edge lines, bus lane, etc. and ‘no parking zones’, ‘warning lines’, etc.</p> <p>(2) <u>Markings at intersections</u> – stop lines, pedestrian crossings, direction arrows, give way, marking on approaches to intersection, speed change lanes, box marking, etc.</p> <p>(3) <u>Marking at hazardous locations</u> – obstruction approaches, carriageway width transition, road-rail level crossings, check barriers, etc.</p> <p>(4) <u>Marking for parking</u> – parking space limits, parking restrictions, bus stops etc.</p> <p>(5) <u>Word messages</u> – stop, slow, bus, keep clear, right turn only, exit only, etc.</p> <p><u>Object markings</u> – kerb marking, objects within the carriageway, objects adjacent to the carriageway, etc.</p>	<p>02 M</p> <p>02 M (any four 1/2 M for each)</p>
Q.5	(b) Ans.	<p>Define:</p> <p>(i) Land slide (ii) Re-entrant curve (iii) Salient curve (iv) Hair pin bend curve</p> <p>(i) Land slide: The downward and outward movement of slope forming materials such as natural rocks, soils, artificial fills, etc. is known as land slide or land slip.</p> <p>(ii) Re-entrant curve: The curves having their convexity on the inner edge of a hill road are called re-entrant curves.</p> <p>(iii) Salient curve: The curves having their convexity on the outer edges of a hill road are called salient curves.</p> <p>(iv) Hair pin bend curve : The curve in a hill road which changes its direction through an angle of 180° or so, down the hill on the same side is known as hair pin bend curve</p>	<p>04 M (01 M for each)</p>
Q.5	(c) Ans.	<p>Define gradient. State its types. State IRC specifications of gradients.</p> <p>Gradient : The rate of rise or fall provided to the formation of a road along its alignment is called grade or gradient.</p> <p>Types of Gradient : The following are the different types of road gradient :</p> <p>(1) Ruling gradient (2) Limiting gradient (3) Exceptional gradient (4) Average gradient (5) Floating gradient (6) Minimum gradient</p> <p>The IRC specifications of gradients are given in table below:</p>	<p>01 M</p> <p>01 M (Any two 1/2 M for each)</p>



Sr. No.	Nature of Area	Gradients			02 M (for table and values)
		Ruling	Limiting	Exceptional	
1	Plain or Rolling Area	3.3 % (1 in 30)	5 % (1 in 20)	6.7 % (1 in 15)	
2	Mountainous Area	5 % (1 in 20)	6 % (1 in 16.7)	7 % (1 in 14.3)	
3	Steep Area	6 % (1 in 16)	7 % (1 in 14.3)	8 % (1 in 12.5)	
Q.5	(d) Ans.	<p>Explain the following road defects:</p> <p>(i) Raveling (ii) Mud pumping</p> <p>(i) Ravelling :</p> <p>On some road stretches with premixed bituminous surfacing, progressive disintegration of the surface may occur due to binder failing to bind the aggregates, these results in the aggregates of the surface getting gradually loosened from the surface due to the moving traffic. This type of pavement distress is called “Ravelling”. Ravelling may be caused due to one or more of the following errors that could have occurred during the construction process of the bituminous pavement surfacing:</p> <p>(a) Construction during wet weather conditions. (b) Delayed rolling after the bituminous mix has cooled down. (c) Insufficient binder content in the mix. (d) Improper gradation of the aggregates or segregation of the mix during laying. (e) Over-heating of the binder or the bituminous mix.</p> <p>(ii) Mud pumping :</p> <p>The ejecting out of the soil slurry through the joints and cracks of road slab when depressed due to traffic wheel loads in known as mud pumping. In case, the water finds its access to the soil subgrade of road slab, it forms soil slurry or mud and thus weakens the subgrade. Due to application of repeated wheel loads, the soil under the joints gets consolidated and thus a water pocket is formed under the joint. When the wheel load comes on one side of the joint, the road slab deflects, ejecting the water out of the joint. Since this also carried with it small particles of soil, it is called soil slurry or mud, and this ejecting out of the soil slurry or mud is known as mud pumping.</p>			02 M 02 M
Q.5	(e) Ans.	<p>Write the use of the following earth moving equipment :</p> <p>(i) Scraper (ii) JCB (iii) Drag line (iv) Roller</p> <p>(i) Use of Scraper :-</p> <p>The scraper is used</p> <p>(1) To excavate soft soils. (2) To load the excavated soil. (3) To transport the excavated soil. (4) To dump the excavated soil at the required site.</p> <p>(ii) Use of JCB :-</p> <p>The JCB is used for construction, small demolitions, light transportation of building material, powering building equipment, digging holes or excavation, landscaping, breaking asphalt and paving roads.</p> <p>(iii) Use of Dragline :-</p> <p>The dragline is used for</p> <p>(i) Road excavation (ii) Deep down pipe driving (iii) Surface mining (iv) Construction of ports, harbor etc. (v) Deep down excavation</p>			04 M 01 M for each

		<p>(vi) Under water excavation</p> <p>(iv) Use of Roller :- A Roller is used to compact soil, gravel, concrete or asphalt in the construction of roads and foundations. Similar roller are used also at landfills or in agriculture.</p>																
Q.5	(f)	<p>Draw a neat sketch of any one. (i) Bulldozer (ii) Drag line (Draw line diagram only. No three dimensional sketch is essential.)</p> <p>Ans. (i) Sketch of Bulldozer is given below :</p> <div style="text-align: center;">  </div> <p>(ii) Sketch of Dragline is given below:</p> <div style="text-align: center;">  </div>	<p>04 M Any one (02 M for diagram 02 M for labeling)</p>															
Q.6	(a) Ans.	<p>Attempt any FOUR: Compare flat wheeled rollers & sheep foot rollers. The comparison between flat wheeled roller and sheep foot rollers are given in table below:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Sr. No.</th> <th style="width: 45%;">Flat wheeled rollers</th> <th style="width: 45%;">Sheep foot rollers</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td>These rollers consist of one large drum in front and two steel drums on the rear.</td> <td>These rollers consist of one or more hollow steel cylindrical drums with rows of steel studs like sheep's foot are mounted on it.</td> </tr> <tr> <td style="text-align: center;">2</td> <td>These rollers may be hand or animal driven or power driven.</td> <td>These rollers may be pulled by tractors.</td> </tr> <tr> <td style="text-align: center;">3</td> <td>These rollers works on the principle of static weight or static pressure.</td> <td>These rollers works on the principle of kneading action.</td> </tr> <tr> <td style="text-align: center;">4</td> <td>These rollers are suitable for compaction of Granular materials.</td> <td>These rollers are suitable for compaction of clayey soils.</td> </tr> </tbody> </table>	Sr. No.	Flat wheeled rollers	Sheep foot rollers	1	These rollers consist of one large drum in front and two steel drums on the rear.	These rollers consist of one or more hollow steel cylindrical drums with rows of steel studs like sheep's foot are mounted on it.	2	These rollers may be hand or animal driven or power driven.	These rollers may be pulled by tractors.	3	These rollers works on the principle of static weight or static pressure.	These rollers works on the principle of kneading action.	4	These rollers are suitable for compaction of Granular materials.	These rollers are suitable for compaction of clayey soils.	<p>04 M (four point 01 M for each)</p>
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Q.6	(b) Ans.	<p>Draw a flow diagram of hot mix bitumen plant.</p>																

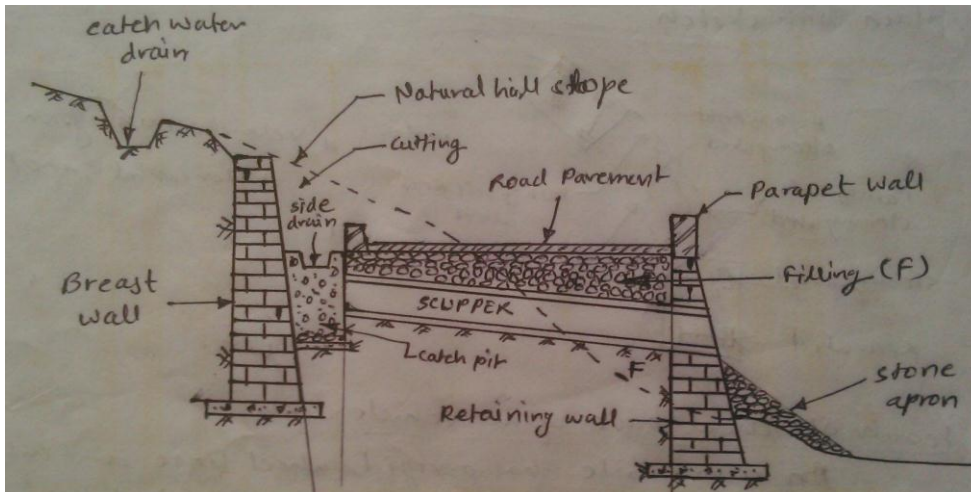
The flow diagram of hot mix bitumen plant is given below:



04 M
(02 M for diagram and 02 M for labeling)

Q.6 (c) **Draw a c/s of hill road & label the components.**

Ans. The cross section of hill road is shown below:



04 M
(02 M for diagram and 02 M for labeling)

Q.6 (d) **Explain in how many ways the water enters the body of the road.**

Ans. The water enters the body of the road in following ways:

- (1) Surface water from the top of pavement enters the body of the road by percolation through cracks and poor pavement surface.
- (2) Surface water enters the body of road from sides of the pavement.
- (3) Sub-soil water from underside of the pavement by capillary rise.
- (4) Sub-soil water from sides of the pavement.
- (5) Intercepted water due to over flooding of cross drainage works.

Any four
01 M
For Each

Q.6 (e) **Write the names of the compacting equipment. Write four uses of the compacting equipment.**

Ans. **Compacting Equipment :-**

The names of the compacting equipment are as follow:

- (1) Smooth wheeled rollers (also called static roller)
- (2) Vibratory rollers
- (3) Pneumatic tyred rollers
- (4) Sheep foot rollers
- (5) Rammers or Hand operated compactors

Any four
1/2 M for each



	<p>Uses of the compacting equipment :-</p> <p>The various uses of the compacting equipment are as follow:</p> <ul style="list-style-type: none">(i) To prepare subgrade of soils for both flexible and rigid pavements.(ii) To compact thick layers of road metal in WBM road construction.(iii) To compress bituminous concentrated layers in roads.(iv) To consolidate the stone chippings, soil and sand.(v) To consolidate the sides of embankments of road. <p>To compact concrete slabs in rigid pavements.</p>	<p>Any four 1/2 M for each</p>
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