

## CHAPTER - 01

### SHORT QUESTIONS ANSWER

1. Name the different types of roads as per IRC classification. [2016, 1 (b)]

Ans. National Highway, State Highway, Major District Road, Other District Road, Village Road.

2. WHAT IS IRC? 2019 (W), 1(A)

ANS: IRC was set up in December, 1934 on the recommendations of the **Indian Road** Development Committee best known as Jayakar Committee set up by the Govt. of **India** with the objective of **Road** Development in **India**.

### MEDIUM QUESTIONS ANSWER

1. Write down the various functions of "Central Road Research Institute". [2017, 2 (a)]

Ans. The Central Road Research Institute Delhi (CRRRI)

The institute was set up in 1950. It is an organ of the council of scientific and industrial research and its functions include.

- (i) Fundamental and applied research on economic utilization of local resources for low cost road construction and also on road designs as well as, road traffic and safety.
- (ii) Execution of pilot road projects, in different climatic regions of the country, for demonstration of new ideas and techniques.
- (iii) Collaborative research with other institutions affording technical support and guidance to various highways departments in the design and execution of major projects.
- (iv) Propagation of results of research and
- (v) Training of road technologists and research personnel from universities and highway department.

Besides research work, consultancy services of the institute render technical advice to the highway. Engineering organisations in the country for the solution of various problems faced by them.

2. What are the significant recommendations of Jayakar Committee report? 2019 W, 2(g)

ANS: Jayakar Committee submitted its report in the year 1928. The most important recommendations made by the Committee are:

- 1) The road development in the country should be considered as a national interest as this has become beyond the capacity of provincial governments and local bodies.
- 2) An extra tax should be levied on petrol from the road users to develop a road development fund called 'Central Road Fund'.
- 3) A Semi-official technical body should be formed to pool technical know-how from various parts of the country and to act as an advisory body on various aspects of roads.
- 4) A research organization should be instituted to carry out research and development work pertaining to roads and to be available for consultations.

## CHAPTER - 02

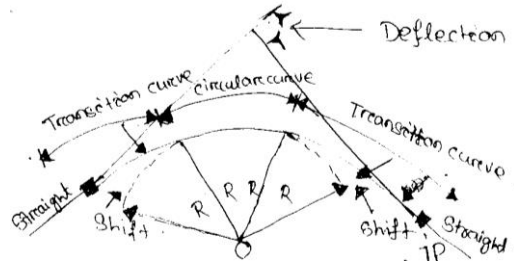
### SHORT QUESTIONS ANSWER

1. Define right of way [2015, 1 (a)] ,2018,1(a)]

Ans. Right of way is the area of land acquired for the road along its alignment. It depend on the importance of the road and possible future development.

2. Draw a general shapes of different types of transition curves. [2015, 2 (a)],2019 ,1(b)

Ans.



3. What is the purpose of providing super elevation in roads ? [2018],2019 1(h)

Ans. The super elevation should be provided to fully counteract the centrifugal force due to 75% of the design speed and limiting the maxim super elevation to O.O

4. Differentiate between 'camber' and 'gradient'. [2016, 1 (a)]

Ans. Camber is the slope provided to the road surface in the transverse direction to drain off the rain water from the road surface. Gradient is the rate of rise or fall along the length of the road with respect to the horizontal. It is expressed as a ratio of 1 in x or as a percentage.

5. What do you mean by transition curve ? [2017, 1 (c)]

Ans. Transit curve are provided in hilly roads. The length of transit curve is to be calculated from the formula.

6. What is Kerb ? [2016, 1 (g)]

Ans. Road kerb are indicators between the edge of a carriageway and the footpath, road islands, refuge islands, medians etc.

7. Differentiate between right of way and formation width. [2016, 1 (i)]

Ans. The formation widths of pavement carriageway in India as follows.

Highway Classification	Pavement width, m	Roadway width m
(i) NH and SH	-	-
➤ Two lane	7.00	8.80
➤ Single lane	3.75	6.25
(ii) MDR	3.75	4.75
(iii) ODR	3.75	4.75

(iv) VR

3.00

4.00

Right of way is the area of land acquired for the road along its alignment. It depends on the importance of the road and possible future development.

8. What is 'cross slope' ? [2017, 1 (j)]

Ans. Cross slope or camber is the slope provided to the road surface in the transverse direction to drain off the rain water from the road surface.

9. Where super elevation is provided in a road alignment ? [2017, 1 (l)]

Ans. The super elevation is provided a transverse slope through the length of horizontal curve.

10. What is OSD?

ANS: The minimum distance open to the vision of the driver of a vehicle intending to overtake slow vehicle ahead with safety against the traffic of opposite direction is known as the minimum overtaking sight distance.

11. what do you mean by highway alignment? 2019 ,3(a)

ANS: **Highway Alignment** is the position or layout of centre line of the **highway** on the ground is called the **alignment**. it includes straight path, horizontal deviation and curves.

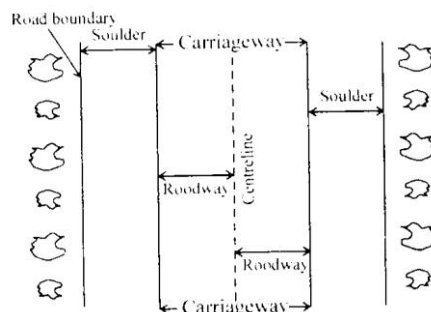
12. Specify the recommended values of S.E for plain & rolling terrain by IRC.2019-1(b)

ANS: IRC had fixed the maxm limit of S.E in plain & rolling terrain & is snow bound areas as 7 percent taking such traffic into consideration.

### MEDIUM QUESTIONS ANSWER

1. With a neat sketch (line diagram) show the following terms relating to road:  
Road boundary, Right of way, Road way, Carriage, Shoulder, Control line.

Ans.



[2015(S), 1 (b)]

2. Calculate the stopping sight distance for a speed of 80 kmph for two way traffic in a two lane road & two a traffic on a single road. The co-efficient of friction is .30 and total reaction time is 2.5 seconds.

[2018,1(c)],2019 2(b)

Ans. Co-efficient of friction = 0.30

Total reaction time = 2.5 seconds.

Stopping distance = lag distance  
+ breaking distance.

$$= vt + \frac{v^2}{2gf}$$
$$v = 80 \text{ kmph} = \frac{80}{3.6} = 22.22 \text{ m/s}$$
$$t = 2.5 \text{ s. } g = 9.8, f = 0.30$$
$$\text{Stopping distance} = vt + \frac{v^2}{2gf}$$
$$= 22.22 \times 2.5 + \frac{(22.2)^2}{2 \times 9.8 \times 0.30}$$
$$= 55.55 + \frac{493.73}{5.88}$$
$$55.55 + 83.97 = 139.52 \text{ m.}$$

Two a traffic two lane road=140m & single

3. Design the rate of super elevation for a horizontal highway curvy radius 450m and speed 90 kmph. [2016, 2 (c)],2019 ,3(b)

Ans. For mixed traffic, super elevation is given by

$$e = \frac{V^2}{225R}$$

Here  $V = 90 \text{ kmph}, R = 450\text{M}$   
 $e = 0.08$

As the value is greater than the maximum super elevation 0.07. the actual super elevation to be provided is restricted to 0.07.

$$\therefore f = \frac{V^2}{127R} - 0.07 = 0.142$$

As this value is less than 0.15, the design is safe with a super elevation of 0.07.

4.Explain PIEV theory. 2019 ,2(d)

ANS: 1) Perception

2) Intellection

3) Emotion

4) Violation

1)Perception time: is time required for the sensations received by the eyes or ears of the driver to be transmitted to the brain through the nervous system & spinal cord or it is the time required to perceive an object or situation.

2)Intellection time : is the time require for the driver to understand the situation it is also the time required for comparing the different thoughts.

- 3) Emotion time: is the time elapsed during emotional sensational and other mental disturbance such as fear, anger or any other emotional feeling superstition etc
- 4) Volition time: is the time taken by the driver for the final action such as brake application.
- 5.

### LONG QUESTIONS ANSWER

1. Calculate the SSD on a highway at a descending gradient of 2.35% for a design speed of 65kmph. Assume other data as per IRC recommendation. [2015 (w), 1 (c)]

Ans. Given data

$$V = 65 \text{ kmph}$$

$$n = 2.35\% \text{ (descending gradient)}$$

$$\text{Assume } t = 2.5 \text{ dec.}$$

$$f = 0.36 \text{ (v = 65 kmph)}$$

$$\begin{aligned} \text{SSD in m} &= 0.278 vt + \frac{V^2}{254 (f - 0.01 \times n)} \\ &= 0.278 \times 65 \times 2.5 + \frac{(65)^2}{254 (0.36 - 0.01 \times 2.35)} \\ &= 94.60 \cong 95 \text{ m.} \end{aligned}$$

2. Design the rate of super elevation for a horizontal highway curve radius 90m and speed 50 kmph [2015, 3 (c), 2018, 2, b]

Ans. Given R = 90m

Speed,  $V = 50$  kmph

$f = 0.15$

$$e + f = \frac{V^2}{127R}$$

$$e + 0.15 = \frac{(50)^2}{127 \times 90}$$

$$\Rightarrow e = 0.22 - 0.15 = 0.07 \text{ or } 7\%$$

3.

## CHAPTER - 03

### SHORT QUESTIONS ANSWER

1. What is meant by 80/100 grade of bitumen ? [2015, 3 (a)]

Ans. 80/100 grade of bitumen means that the penetration value of this bitumen ranges from 80 to 100 mm at standard test conditions.

2. Differentiate between bitumen and tar. [2015 3 (a),2018,6a],2019 ,4(a)

Ans. Bitumen :- Crude petroleum obtained from different places are quite different in their composition. The portion of bituminous material. Present in the petroleum's may widely differ depending on the source. The successive fractions obtained yield gasoline, naphtha, kerosene and lubricating oil, the residue would be petroleum bitumen.

Tar :- Tar is the viscous liquid obtained when natural organic materials such as wood and coal carbonized or destructively distilled in the absence of air. Based on the material from which tar is derived. It is referred to as wood tar or coal tar, the latter is more widely used for road work because it is superior.

3. Mention the acceptance criteria of testing aggregates in impact test. [2017, 1 (f)]

Ans. The toughness of stone or the resistance of aggregate to fracture under repeated impacts is called impact value of aggregates.

The aggregate impact value indicates a relative measure of resistance of aggregate to impact.

4. What is 'flakiness index' ? [2017, 1 (h)]

Ans. The flakiness index of aggregate is the percentage by weight of aggregate particles whose least dimension is less than three fifths or 0.6 of their mean dimension.

5. What is a cut back bitumen? 2019,1©

ANS: **Cutback Bitumen** ( Liquid **Bitumen** ) is **Bitumen** that is dissolved in a solvent . Typical solvents include Naptha, gasoline and kerosene, white spirit etc.

6. Define water bound macadam. 2019 6(a)

ANS: The road whose wearing course consists of clean crushed aggregates, mechanically interlocked by rolling and **bound** together with filler material and **water** laid on a well compacted base course, is called **water bound macadam**.

7. NAME THE COMMON BINDERS. 2019 -1(E)

\*Alumina silicate

\*Fly ash

\*Bentonite

\*Bitumen

\*Portland cement

\*Calcium aluminate

## MEDIUM QUESTIONS ANSWER

1. Explain the procedure of finding out the aggregate impact value. [2017, 5 (b)]

Ans. A test designed to evaluate the toughness of stone or the resistance of the aggregates to fracture under repeated impact is called impact test. The aggregate impact test is commonly carried out to evaluate the resistance to impact of aggregates and has been standardized by ISI.

The aggregate impact value indicates a relative measure of resistance of aggregate to impact, which has a different effect than the resistance of gradually increasing compressive stress. The aggregate impact testing machine consists of a metal base and a cylindrical steel cup of internal diameter 10.2 cm and depth 5 cm in which the aggregate specimen is placed. A metal hammer of weight of 13.5-14.0 kg having a free fall from a height 38cm is arranged to drop through vertical guides.

Aggregate specimen passing 12.5 mm sieve and retained on 10 mm sieve is filled in the cylindrical measure in 3 layers by tamping each layer by 25 blows. The sample is transferred from the measure to the cup of the aggregate impact testing machine and compacted by tamping 25 times. The hammer is raised to a height of 38cm above the upper surface of the aggregate in the cup and is allowed to fall freely on the specimen. After subjecting the test specimen to 15 blows, the crushed aggregate is sieved on 2.36 mm sieve. The aggregate impact value is expressed as the percentage of the fine formed in terms of the total weight of the sample.

2. What are the requirements of good road aggregates ? [2016, 2 (d)]

Ans. Stones used for road work should satisfy the following tests :-

- i. Hardness
- ii. Toughness
- iii. Durability
- iv. Cementing property (if used for WBM roads)
- v. Hydrophobics (for bituminous surface)

The requirements of gravel for road work are that, it should be well graded (6.4 mm to 38 mm) and should have a fineness modulus of not less than 5.75.

Sand for road work should have the following properties :-

- i. Sharpness
- ii. Well graded
- iii. Clean of all silts, clay and organic matter
- iv. Hard, tough and durable



3. Loss Angle's abrasion value. [2012, 6 (b)]

Ans. The Los Angeles machine consists of a hollow cylinder closed at both ends, having inside diameter 70 cm and length 50 cm and mounted so as to rotate about its horizontal axis. The abrasive charge consists of cast iron spheres of approximate diameter 4.8 cm and each of weight 390 to 445g.

5 MARKS

1. Describe the Los Angeles abrasion test for road aggregates & explain its significance. 2019 -20
2. The aggregate used in surface course of the highway pavements are subjected to wearing due to movement of traffic.
3. When vehicles move on the road, the soil particles present between the pneumatic tyres and road surface cause abrasion of road aggregates. The steel rimmed wheels of animal driven vehicles also cause considerable abrasion of the road surface.
4. Therefore, the road aggregates should be hard enough to resist abrasion. Resistance to abrasion of aggregate is determined in laboratory by Los Angeles test machine.
5. The principle of Los Angeles abrasion test is to produce abrasive action by use of standard steel balls which when mixed with aggregates and rotated in a drum for specific number of revolutions also causes impact on aggregates.

### LONG QUESTIONS ANSWER

1. Explain briefly with neat sketch of CBR Test. [2015, 2 (c)]

OR

What is the purpose of finding out CBR values ? Explain the procedure finding out CBR values. [2013, 6 (c)]

Ans. This is a penetration test developed by the California division of highways as a method for evaluating the stability of soils sub grade and other flexible pavement materials.

Procedure of Finding out CBR Values :-

The CBR test may be conducted in the laboratory on a prepared specimen in a mould or in-situ in the field.

The laboratory CBR apparatus consists of a mould 150 mm diameter with a base plate and a collar, a loading frame with the cylindrical plunger of 50 mm diameter and dial gauges for measuring the expansion on soaking and the penetration values.

Briefly the penetration test consists of causing a cylindrical plunger of 50 mm diameter to penetrate a pavement component material at 1.25 mm/minute. The load values to cause 2.5mm and 5.0 mm penetration are recorded. These loads are expressed as percentages of standard load values at respective deformation levels to obtain CBR value. The standard load values obtained from the average of a large

number of tests on crushed stones are 1370 and 2055 kg respectively at 2.5 and 50 mm penetration.

The specimen in the mould is subjected to four days soaking and the swelling and water absorption values are noted. The surcharge weight is placed on the top of the specimen in the mould and the assembly is placed under the plunger of the loading frame. The load values are noted corresponding to penetration values of 0.0., 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 and 12.5mm, Then the load penetration graph is plotted. Alternatively the load values may be converted to pressure values and plotted against the penetration values.

The CBR value is calculated using the relation

$$\text{CBR \%} = \frac{\left[ \begin{array}{c} \text{load sustained by the specimen} \\ \text{at 2.5 or 5.0mm penetration} \end{array} \right]}{\left[ \begin{array}{c} \text{load sustained by standard aggregates} \\ \text{at the corresponding penetration level} \end{array} \right]} \times 100$$

Material passing 20 mm sieve is only used in the test. The field CBR test is carried out using in-situ penetration test.

The test is meant for soils and is also carried out on go base and granular base course material.

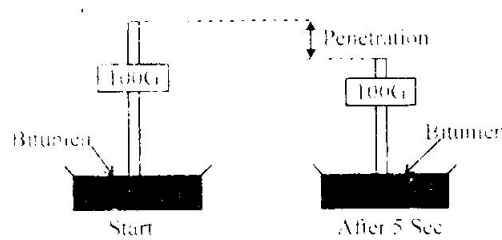
2. What are the various tests carried out on bitumen ? [2016, 2 (b)]

Ans. Bitumen is available in variety of types and grades. To judge the suitability of these binders various physical, tests have been specified by agencies like ASTM, Asphalt Institute tests, British Standards Institution and the ISI. These tests include penetration test, ductility tests, softening point test and viscosity test. For classifying bitumen and studying the performance of bituminous pavements, the penetration and ductility tests are essential. The other tests like softening point and flash and fire point tests are more importance to guide the paving technologies during field operations. In recent years, it has been recognized that the above tests are not sufficient to define the temperature susceptibility of the bituminous materials. The bitumen from different sources possessing same penetration value at a specified temperature may exhibit entirely different viscous characteristics at the application or service temperatures. These tests therefore may need intensive correlation with fundamental property like viscosity.

The various tests on bituminous materials are :-

1. Penetration tests.
2. Ductility tests
3. Viscosity tests.
4. Float test

5. Specific gravity test
6. Softening point test
7. Clash and rife point test
8. Solubility test
9. Spot test
10. Loss on heating test.
11. Water content test.
1. Penetration Tests :- The penetration test determines the hardness or softness of bitumen by measuring the depth in tenths of a millimeter to which a standard loaded needle will penetrate vertically in five seconds The sample is maintained at a temperature of 25<sup>0</sup>C. The concept of penetration test is shown in figure. Indian standard institution has standardized the equipment and test procedure.



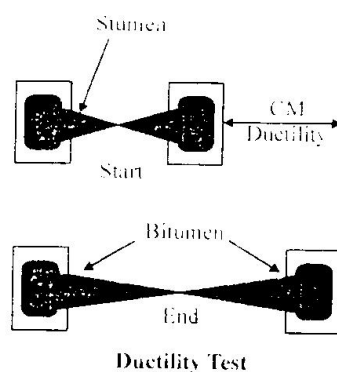
The penetrometer consists of a needle assembly with a total weight of 100 g and device for releasing and locking in any position. There is a graduated dial to read penetration value to 1/10th of millimeter.

The bitumen is softened to a pouring consistency, stirred thoroughly and poured into containers to a depth at least 15mm in excess or the expected penetration. The sample containers are then placed in a temperature controlled water bath at a temperature of 25°C for one hour. The sample with container is taken out and the needle is arranged to make contact with the surface of the sample. The dial is set to zero or the initial reading is taken and the needle is released for 5 seconds. The final reading is taken on dial gauge. At least three penetration tests are made on this sample by testing at distances of at least 10mm apart. After each test the needle is disengaged and wiped with benzene and dried. The depth of penetration is reported in one-tenth millimeter units. The mean value of three measurements is reported as a penetration value. It may be noted that the reported as a penetration value. It may be noted that the penetration value is largely influenced by any inaccuracy as regards pouring temperature, size of needle, weight placed on the needle and the test temperature.

The bitumen grade is specified in terms of penetration value 80-100 or 80/100 grade bitumen means that the penetration value of the bitumen is in the range 80 to 100 at standard test conditions. The penetration test is applied almost exclusively to bitumen. As road tars are soft, the penetration test cannot be carried out on these materials. Other consistency tests are used for tars, cutbacks and emulsions. The penetration values of various types of bitumen used in pavement construction in this country range between 20 and 225, 30/40 and 80/100 grade bitumen are more commonly used, depending on construction type and climate conditions. In hot climates a lower penetration grade bitumen like 30/40 bitumen is preferred.

2. Ductility test :- In the flexible pavement constructions where bitumen binders are used, it is important that the binders form ductile thin films around the aggregates. This serves as a satisfactory binder in improving the physical interlocking of the aggregate bitumen mixes. Under traffic loads the bituminous pavement layer is subjected to repeated deformation and recoveries. The binder material which does not possess sufficient ductility would crack and thus provide pervious pavement surface. Ductility test is carried out on bitumen to test this property of the binder. The test is believed to measure the adhesive property of bitumen and its ability to stretch. The bitumen may satisfy the penetration value but may fail to satisfy the ductility requirements. Bitumen paving engineer would however want that both test requirements are satisfied in the field jobs. Penetration and ductility tests cannot in any case replace each other.

The ductility is expressed as the distance in centimeters to which a standard briquette of bitumen can be stretched before the thread breaks. The test is conducted at 27°C and at a rate of pull of 50mm per minute. The test set up is shown in fig. The cross section at minimum width of the specimen is 10 mm x 10 mm.



The ductility machine functions as constant temperature water bath with a pulling device at a precalibrated rate. Two clips are thus pulled apart horizontally at a uniform speed of 50mm per minute.

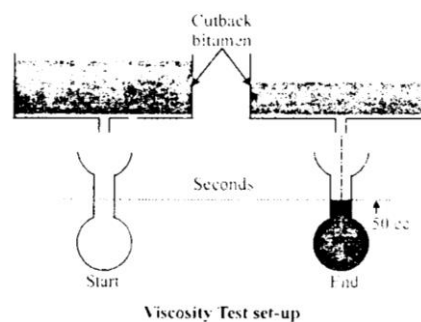
The bitumen sample is heated and poured in the mould assembly placed on a plate. The samples along with the moulds are cooled in air and then in water bath maintained at 27°C. The excess bitumen material is cut and the surface is leveled using a hot knife. The mould assembly containing sample is replaced in water bath of the ductility testing machine for 85 to 95 minute. The sides of the mould are removed, the clips hooked on the machine and the pointer is adjusted to zero. The distance upto the point of breaking of thread is reported in centimeters as ductility value. The ductility value gets seriously affected by factor such as pouring temperature, dimensions of briquette, level of briquette in the water bath, presence of air pockets in the modulus briquettes, test temperature and rate of pulling.

The ductility values of bitumen vary from 5 to over 100 for different bitumen grades. A minimum ductility value of 75 mm has been specified by the ISI for bitumen's of grades 45 and above, obtained from sources other than Assam Petroleum (i.e. S 45, and above) the minimum ductility value may be 50 mm for bitumen's of grades S 35, obtained from these sources. However as the bitumen produced from Assam Petroleum in India have much lower ductility values, the minimum ductility value specified is only 15 mm for the bitumen grades A 65 to 200 for use in certain regions.

3. Viscosity test :- Viscosity is defined as inverse of fluidity. Viscosity thus defines the fluid property of bituminous material. Viscosity is the general term for consistency and it is measure of resistance to flow. Many researchers believe that grading of bitumen should be by absolute viscosity unit instead of the conventional penetration units.

The degree of fluidity of the binder at the application temperature greatly influences the strength characteristics of the resulting paving mixes. High or low viscosity during mixing or compaction has been observed to result in lower stability values. There is an optimum value of viscosity for each aggregate gradation of the mix and bitumen grade. At low viscosity, the bituminous binder simply lubricates the aggregate particles instead of providing a uniform film for binding action. Similarly high viscosity also resists the compactive effort and the resulting mix is heterogeneous in character exhibiting low stability values.

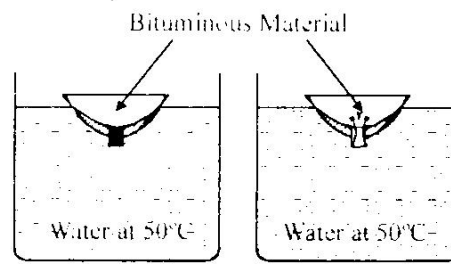
Orifice type viscometer may be used to indirectly find the viscosity of liquid binders like cutback bitumen, emulsion and liquid tar. According to this method, viscosity is measured by determining the time taken by 50 ml of the material to flow from a cup through a specified temperature. Higher the viscosity of the binder, higher will be the time required. This is illustrated in fig. Furol viscosity is a specific test which is used only to measure the viscosity of liquid bituminous materials. It is the number of seconds required for 50 ml of material to flow through an orifice of specified size at specified temperatures. Equipment like sliding plate microviscometer and Brook field viscometer are however in use for defining the viscous characteristics of the bitumen of all grades irrespective of testing temperature.



The viscosity of tar is determined as the time taken in seconds for 50 ml of the sample to flow through 10 mm orifice of the standard tar viscometer at the specified temperature of 35, 40, 45 or 55°C. The viscosity of cutback bitumen is determined as the time taken in seconds for 50 ml of the sample to flow through either 4.0 mm orifice at 25° C or 10 mm orifice at 25 or 40°C. Thus the orifice viscometer is suitable to test tars and cutbacks.

4. Float Test :- There is a range consistency of the bituminous materials for which neither an orifice viscometer test nor a penetration test could be used to define the consistency of the material. The consistency of materials of this group is measured by float test.

The apparatus consists of a float made of aluminum and brass collar filled with the specimen materials to be tested, which is screwed to the test specimen is filled in the collar (mould), cooled to a temperature of 50<sup>0</sup>C and screwed into the float. Refer Fig The float assembly is floated in a water bath at 50<sup>0</sup>C and the time required in seconds for water to force its way through the bitument plug is noted as the float test value. The higher the float test value, the stiffer is the material.



Float test set-up

5. Specific gravity test :- The density of a bitumen binder is a fundamental property frequently used as an aid to classify the binders for use in paving jobs. In most applications the bitumen is weight but finally when used with aggregate system the bitumen content is converted on volume basis using density values. The specific gravity value of bitumen is also useful in bituminous mix design. The density of bitumen is greatly influenced by its chemical composition. Increased amounts of aromatic type compounds or mineral impurities cause an increase in specific gravity.

The specific gravity of bituminous materials is defined as the ratio of the mass of a given volume of the substance to the same of an equal volume of water, the temperature of both being 27°e. The specific gravity is determined either by using a pycnometer or by preparing a cube shape specimen in semi solid or solid state and by weighing in air and water.

Generally the specific gravity of pure bitumen is in the range of 0.97 to 1.02. The specific gravity of cutback bitumen may be lower depending on the type and proportion of diluent used. Tars have specific gravity ranging from 1.10 to 1.25.

## **CHAPTER - 04**

### **SHORT QUESTIONS ANSWER**

1. Differentiate premix carpet and semidense carpet ? [2019, 6 (b)]

Ans. Premixed Carpet consists of coarse aggregate of 12.5 and 10mm sizes premixed with bitumen or tar binder are compacted to a thickness of 20mm serve as surface course of the pavement.

Semidense Carpet when a fairly well graded material according to the specification is used for the construction of the bituminous carpet of thickness 20 to 25mm. The construction method is called semidense carpet.

2. Define Texturing and Separation Membrane. [2015, 7 (a)]

Ans. Texturing is the visual and tactile quality of a surface, the characteristic physical structure given to a material, an object etc. by the size, shape, arrangement and proportion of its parts.

Separation Membrane :- There is a membrane i.e. placed two phase. One phase is called feed and the other is called permeate. A flow of mass is induced from feed to permeate by applying driving force.

3. Distinguish between sub-grade and sub base in a road pavement. [2019, 1 (D)]

Ans. Subgrade is layer of natural soil or filled soil, ready to receive the pavement materials over it.

Subgrade layer is normally made from broken stones which may be rounded or unrounded. If subgrade soil is very poor, it can be laid between subgrade and base layer.

4. Write a Short note.

Road Pavements [2016 (1(c) ii)]

Ans. Concrete Pavers are used when the mixing is done on the site. The concrete pavers do the mixing and laying of concrete on the sub-grade. They consist of bucket and boom arrangement which carry the concrete and discharge and discharge it on the required position. Concrete pavers are rarely used in India.

### **MIDDLE QUESTIONS ANSWER**

1. Explain the purpose and procedure of fly ash stabilization. 2017 ,2(b)

Ans. Purpose of Fly ash Stabilization :

- Soft, wet, clay-type soils cannot be graded or otherwise manipulated during construction without great difficulty.
- Stabilizing these soils with fly-ash makes them dry, strong and easy to grade.
- The self-cementing fly-ash makes the soils hard and strong, creating a platform on which subsequent construction operations can proceed more effectively.

Procedure of Fly-ash Stabilization.

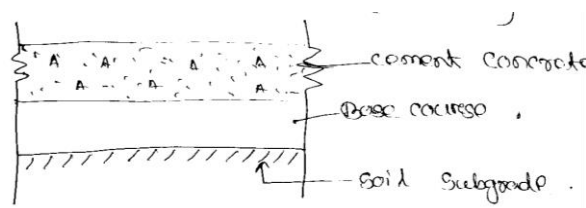
- Preparation of sub-grade or sub-base.
- Pulverization of soil.
- Application of cement and dry mixing.
- Addition of or spraying water and remixing.



- Spreading and grading.
- Compaction.
- Curing the soil-cement layer is allowed moist curing either by preventing the moisture to escape
- or by lovening with moist soil.
- Joint with old work.
- Field control tests.

3. Draw a typical cross section of a rigid pavement road in National Highways and mention the layers of road from the Base. [2015, 1 (b)]

Ans.



Rigid pavement are those which possess note worthy flexural strength or flexural rigidity. The rigid pavement has the slab action and is capable of transmitting the wheel load stresses through a wider area below. The cement concrete pavement slab can very well serve as a wearing surface as well an effective base course.

4. Write a short notes on :- (i) O.L.C. (ii) P.Q.C. (iii) D.B.M. (iv) B.C. (v) W.B.M.

[2015, 3 (b)]

Ans. 1. D.L.C. - function of dry lean concrete is to provide firm base to support traffic over pqc pavement, there should be no bond between pqc and dry lean concrete after laying dry lean concrete with the help of paver and compacted with roller passes minimum eight times up and down i.e total 16 passes. it should be sprayed with MC0 grade bitumen primer cracks will appear from 10m to 15 distance depending upon cement quantity, mix grading of aggregate, temperature and wind speed, before laying pqc, 500 micron anti static polythene sheet shall be laid over dry lean concrete, cube strength lean concrete shall be 5n/mm<sup>2</sup> and above. Higher cement depends upon the strength required for sub base. Size of aggregate shall not be more than 20 mm. good mix falls in the middle portion, weaker mix falls at the ends. Take sample from the end and compare with the middle portion of concrete. Difference in strength shall vary more than 6%.

2. P.Q.C. PURPOSE - The purpose of this Quality Plan for Construction of Pavement Quality Concrete (PQC) is to provide detailed Construction Methodology, Materials used, Resources deployed.

The Scope of this Segmental Quality Plan/ Methodology shall covers the construction of pavement quality concrete insertion of dowel bars, tie bars in accordance with the requirement of Technical Specifications and in conformity with the line, grades and cross sections shown in drawings. It covers the following activities :

Selection, Testing and Acceptance of all incorporated Materials for PQC.

- Design of Mixes for PQC and Trials, Acceptance etc.
- Details of Plant, Equipment / Machinery as required in execution of PQC.
- Batching, Mixing, Transporting, Placing, Finishing and Curing of Concrete for PQC.

3. D.B.M - Dense Bituminous Macadam (DBM) is a binder course used for roads with more number of heavy commercial vehicles. In DBM mix, there is a wide scope for varying the gradation to obtain a good mix without affecting the durability of pavement. The specification deals with the basic outline design construction control needed for DBM to be used as binder or base course pavement.

4. BC - Bituminous concrete is a type of construction material used for paving roads, driveways, and parking lots. It's made from a blend of stone and other forms of aggregate materials joined together by a binding agent. This binding agent is called "bitumen" and is a by-product of petroleum refining. It has a thick, sticky texture like tar when heated, then forms a dense solid surface once it dries. Bituminous concrete is also widely known as asphalt in many parts of the world.

Despite its name, this material is quite different than standard concrete, and contains no cement. While most cement-based surfaces are white or gray, bituminous concrete is known for its distinctive black appearance. It is often laid right over a gravel base layer to form new roads and parking lots, but may also be poured over existing concrete to repair or smooth out bumps and voids. Once the bituminous concrete has been poured onto the roadway, installers use large paving machines to smooth and compact the surface.

5. W.B.M. - water bound macadam is a base course having stone dust mixed in it, the main difference in base course and water bound is that base course have no stone dust in it , where as in case of water bound macadam's water proofing is done by providing a layer of stone dust over a layer of base course. Water Bound Macadam (WBM) is a base course and mixing of binding material such as mooram, Clay soil etc. A layer of Stone By Grade (90mm to 63mm or 63mm to 40mm) and compress to it as a Dry Roll

by Roller and then a layer of binding material placed on it and Fully water than again compaction by Roller.

5. State the causes of flexible pavement with neat sketch. [2015, 5 (b)]

OR

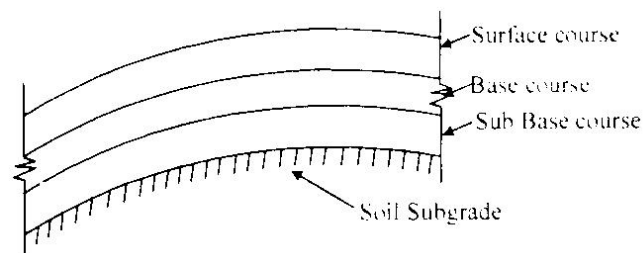
What are the different components of a flexible pavement ?

Explain the functions of each? [2019, 4 (c)]

Ans. A flexible pavement consists of four components (i) soil subgrade (ii) sub-base course (iii) base course and (iv) surface course.

- (i) Soil sub-grade :-

The soil sub-grade is a layer of natural soil prepared to receive the other layers of the pavement. The loads on the pavements are ultimately supported by the soil sub-grade and dispersed to the earth mass. It is essential that at no time, the soil sub-grade is over-stressed. It means that the pressure transmitted on the top of the subgrade is within the allowable limit, not to cause excessive stress condition or to deform the same beyond the elastic limit. Therefore it is desirable that at least top 50 cm layer of the sub-grade soil is well compacted under controlled conditions of optimum moisture content and maximum dry density. It is necessary to evaluate the strength properties of the soil sub-grade. This helps the designer to adopt the suitable values of the strength parameter for design purposes and in case this supporting layer does not come up to the expectations, the same is treated or stabilized to suit the requirements.



- (ii) Sub-base and Base Course :-

These layers are made of broken stones, bound or unbound aggregate. Sometimes in sub-base course a layer of stabilized soil or selected granular soil is also used. In some places boulder stones or bricks are also used as a sub-base or soling course. However at the sub-base course, it is desirable to use smaller size graded aggregates or soil-aggregate mixes or soft aggregates instead of larger boulder stone soling course of brick on edge soling course, as these have no proper interlocking and therefore have lesser resistance to sinking

into the weak subgrade soil when wet. When the subgrade consists of fine grained soil and when the pavement carries heavy wheel loads, there is a tendency for these boulder stones or bricks to penetrate into the wet soil, resulting in the formation of undulations and uneven pavement surface in flexible pavements. Sub-base course primarily has the similar function as of the base course and is provided with inferior materials than of base course. The functions of the base course vary according to type of pavement.

Base course and sub-base course are used under flexible pavement primarily to improve the load supporting capacity by distributing the load through a finite thickness, Base course are used under rigid pavement for :-

- (i) Preventing pumping
- (ii) Protective the subgrade against frost action.
- (iii) Surface Course/Wearing Course :-

The purpose of the wearing course is to give a smooth riding surface that is dense. It resists pressure exerted by tyres and takes up wear and tear due to the traffic, Wearing course also offers a water tight layer against the surface water infiltration. In flexible pavement, normally a bituminous surfacing is used as a wearing course, In rigid pavements the cement concrete acts like a base course as well as wearing course. There are many types of surface treatment employed as wearing course. The type of surface depends upon the availability of materials, plants and equipment and upon the magnitude of surface loads.

6. What are the basic difference between a rigid pavement and flexible pavement ?

[2016, 2 (e)]

Ans. For design purposes, pavement design falls into two well defined categories namely Flexible and Rigid. Water bound macadam roads stabilized soil roads, and other low cost roads which consist of various layers of road building material compacted so as to form a void free compact and comparatively elastic bed come under the category of Flexible pavements. The slab of cement concrete roads on the other hand behaves as a slab or cantilever where in the entire section of the slab resists the deformation of the surface, reinforced or plain comes under the category of Rigid pavements. A third category of pavement in between these two may be termed as semi-rigid pavement. Cement grouted pavement may be classified under this class of pavement.

Table gives the comparative properties of the two main types of pavement i.e. Flexible and Rigid pavements.

Sl.No (1)	Characteristics (2)	Flexible Pavements (3)	Rigid Pavements (4)	Remarks (5)
1.	Effect of loading (a) Normal loading. (b) Excessive loading.	Adjusts itself to loading by under going elastic deformation. Yields to excessive stress resulting in local depression of surface	Tends to act as a beam or cantiever.  Reptures by producing a crank on surface	
2	Temperature effect.	Does not produce any stresses	Heavy temperature stresses are produced.	
3	After effect of heavy loading.	The surface has self healing properties as it deforms elastically	The damage cause to the surface under heavy loading is of a permanent nature	

## 7. What is soil stabilization & cement stabilization ?2019 (7)

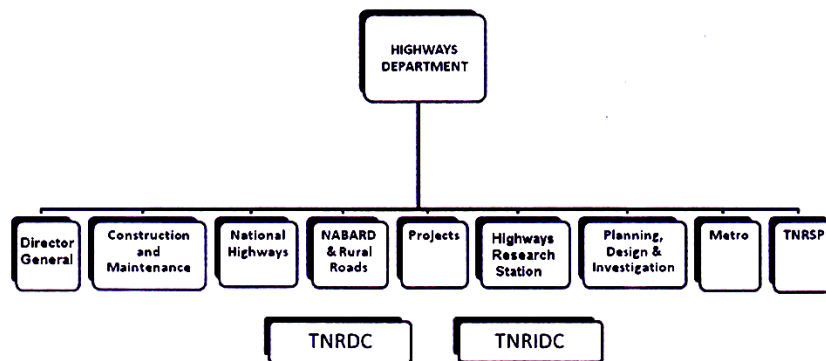
**ANS:** Soil Stabilization is the alteration of soils to enhance their physical properties. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations.

The addition of cement to a soil, which acts as a binding agent and produces a weak form of concrete called soil cement. The quantity of cement to be added depends upon the type of soil. Cement can be used with most types of soil, providing the clay fraction is reasonably small and other specified impurities are not present. A small percentage of lime is usually added. With very poor soils, cement stabilization may be uneconomical or impracticable.

### LONG QUESTIONS ANSWER

1. Draw a flow chart of organisation of State Highway Construction Department and specify their duties and responsibilities. [2015, 7 (c)]

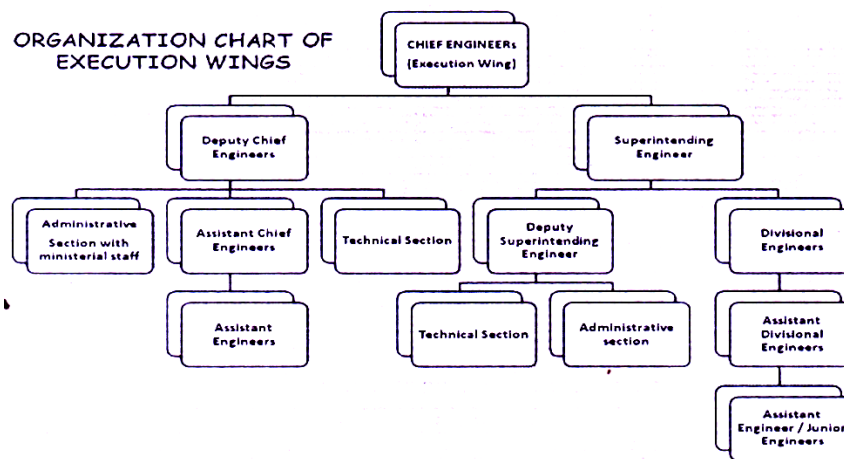
Ans.



Highways Department functions under the overall coordination of the Director General. There are eight wings for execution of projects as follows :-

- Construction & Maintenance wing - State fund works
- National Highways wing - Central fund works
- NABARD & Rural Roads wing - NABARD loan assistance works
- Projects wing - Railways Works Programme (fund sharing)
- Metro wing - Chennai Metro Development Programme works
- Tamil Nadu Road Sector Project - World Bank loan assistance works
- Planning, Designs & Investigation Wing

➤ Quality Assurance & Research Wing



- In addition, two companies are executing Special Projects.
- Tamil Nadu Road Development Company
- Tamil Nadu Road Infrastructure Development Corporation

The functions of all the wings are detailed as follows :-

1. OFFICE OF THE DIRECTOR GENERAL

The post of Director General has been created for smooth and efficient functioning of the department and to coordinate the work of all the eight wings. The Director General is also the head of all the Technical Committees.

FUNCTIONS :-

- Overall Planning and Budgeting of Highways Department
  - Establishment and Personnel Administration matters in Highways Department
  - Monitoring Quality of works executed by the Highways Department
  - Monitoring and Managing IT Cell and their Activities relating to epathai systems like Road
  - Maintenance Management System (RMS)
  - Road Accident Data Management System (RADMS), Geographical Information System (GIS)
  - Establishment of Project & Financial Management system (P&FMS) and Collection of Data Utilising
  - Advanced Data Collection Equipment
  - Any other work entrusted by the Government
2. CONSTRUCTION & MAINTENANCE WING
- Maintenance of State Highways, Major District Roads, Other District Roads and bridges.
  - Execution of Part - II scheme works.

- Restoration of roads and bridges affected by natural calamities like monsoons, floods and Tsunami
  - Execution of road and bridge works under Comprehensive Road Infrastructure Development Programme.
  - Formation of bypasses.
  - Implementation of road infrastructure schemes under Public Private Partnership.
  - Maintenance of ODR - Sugarcane Roads.
  - Construction of ROBs / RUBs.
3. NABARD & RURAL ROADS WING
- Execution of bridges and roads with loan assistance from NABARD.
  - Construction of Road Over Bridges / Road under Bridges under Railway Works Programme.
4. PROJECTS WING
- Road Over and Under Bridges at Railway level crossings under Railway Works Programme.
  - Major Bridge works with State funds and NABARD assistance.
  - Formation of Ring Roads and Radial Roads.
  - Formation of Sugarcane Roads with Sugar Cess Fund
5. METRO WING
- Execution of Chennai Metropolitan Development Plan (CMDP) works.
  - Road works, major bridge works and bridge works in road junctions under TNUDP-III.
  - Construction of ROBs / RUBs in Metro areas.
6. NATIONAL HIGHWAYS WING
- National Highways Development comprises plan works and maintenance of roads and bridges on
  - National Highways with the funds of the Government of India.
  - Revamped Central Road Fund scheme works.
  - Inter State Connectivity Scheme works.
  - Economic Importance scheme works.
  - Western Ghats Development Programme works
  - Hill Area Development Programme works
7. TAMIL NADU ROAD SECTOR PROJECT WING

- Road upgradation works with the World Bank assistance.
  - Enhanced road maintenance works.
  - Undertaking studies for projects to be implemented through Public Private Partnership.
  - Strengthening the organisational set-up of Highways Department.
8. QUALITY ASSURANCE AND RESEARCH WING
- Research activities relating to roads and bridges.
  - 3 tier quality assurance for all works implemented by this department.
  - Road safety and traffic improvement works.
9. PLANNING, DESIGN AND INVESTIGATION WING
- Carrying out investigation for new road and bridge works.
  - Preparation of structural designs, drawings and estimates for bridge works costing Rs.2 Crore and above.
10. TAMIL NADU ROAD DEVELOPMENT COMPANY (TNRDC)
- Implementing major PPP projects
  - Management of Chennai Outer Ring Road works.
  - Undertaking Rajiv Gandhi IT Expressway works and maintaining as toll road
  - Improving and maintaining the East Coast Road (Chennai to Puduchery) as toll road
11. TAMIL NADU ROAD INFRASTRUCTURE DEVELOPMENT CORPORATION
- Development of road and bridge infrastructure required in industrial areas.

## **CHAPTER - 05**

### **SHORT QUESTIONS ANSWER**

1. What is the function of breast wall in hill road ? [2016, 1 (e)],2019 ,2(F)

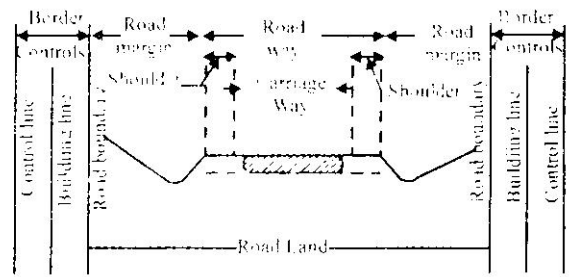
Ans. Breast wall are provided on the inner side of the road to give support to the loose and unreliable soil of the hill side.

### **MIDDLE QUESTIONS ANSWER**

1. Draw a typical cross-section of a road in cutting. [2016,1 (b)]

Ans.



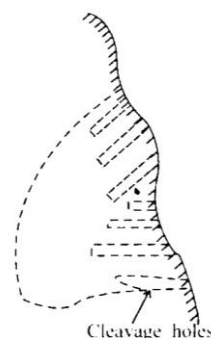


### LONG QUESTIONS ANSWER

1. Enlist the salient features of the design of hill roads. Also draw the cross-section of a typical hill road in cutting. [2018, 2 (c)]

Ans. Features of the design of hill roads :-

- If the rock strata slopes downwards into the hill side, the rock is permitted to overhang the road forming a half tunnel.
- If the strata is inclined towards the hill slope, cutting is continued until the inner slope is at a safe angle to prevent slipping.
- In such a case, biasing and cutting is commenced from top.
- If the rock is soft or loosely stratified, the cutting is commenced at point on the hill side for above the formation level for obtaining sufficient batter for the inner slope.
- Blowing out the difference by firing large mines and then dressing the slope, is another alternative.
- In actual construction, there is great difficulty in remaining rock exactly to the required levels and grade.
- Unless special care is taken, blasting may be slightly short of requirement or it can be over blasting.
- During blasting the drain on hill side is also formed.
- Blasted stores are used for retaining walls, backfilling high retaining walls and aprons etc.



## **CHAPTER - 06**

### **SHORT QUESTIONS ANSWER**

### **MIDDLE QUESTIONS ANSWER**

1. Name the different structures use for surface drainage of roads. Explain about one of them. [2015, 3 (b)]

Ans. There are three types of structures used for cross drainage is to be provided. Also often the water from the side drain is taken across by these cross drain in order to divert the water away from the road, to a water course or valley. The cross drainage structures commonly in use are culverts and small bridges. When a small stream crosses a road with a linear waterway less than about six meter, the cross drainage structures provided is called culvert, for higher values of linear waterway the structure is called a bridge.

### **LONG QUESTIONS ANSWER**

1. Write a short note (i) Mechanical Stabilization (ii) Lime Stabilization (iii) Cement (iv) Fly-ash Stabilization. [2015, 4 (c)]

Ans. (i) Mechanical Stabilization :-

This is the most widely used method of soil stabilization as it is easy, simple and cheap. It is found that is a mixture of soil consisting of two parts of coarse grains and one part of fine grains or two parts of sand and one part of clay is compacted at optimum moisture content, the surface so formed will not deform easily under normal wheel load.

(ii) Lime Stabilization :-

The process of lime stabilization of soil is more or less the same as cement stabilization except that hydrated lime is used in place of cement. The quantity of lime is about 5 to 10 percent by weight and the presence of lime helps in reducing the shrinkage and swelling of soil.

(iii) Cement Stabilization :-

In this method, the binding property of port land cement is made use of to popularly known as soil cement roads.

When cement is added and mixed with soil in presence of water, it more or less forms a type of low strength cement concrete with particles of soil acting as aggregates. The quantity of cement to be added will depend upon type of soil in the subgrade and it has to be carefully determined in each case.

2. Fly-ash Stabilization. [2015, 4 (c)]

Ans.

- In thermal plants in burning of coal for generation of power are producing abundant quantities of ash residue.

- India's thermal power plants produce an estimated 100 million tones of fly ash per annum.
- Soil as a free gift for human being in the construction of highways and railways, soil plays significant role in base filling.
- The geotechnical engineers always try to find out the solution for the construction problems accrued during the construction in weak soil.
- That solution is nothing but their attempt is to increase the bearing capacity of soil for which fly ash is one of the materials used by them in day to day construction work.

3.Explain the purpose of providing breast wall and retaining walls on hill roads.2019 -2(F)

ANS: Breast wall are provided on the inner side of the road to give support to the loose and unreliable soil of the hill side.

**RETAINING WALL:** Retaining wall is a structure that retain (holds back) any material (usually earth) and prevents it from sliding or eroding away. It is designed so that to resist the material pressure of the material that it is holding back.

## **CHAPTER - 07**

### **LONG QUESTIONS ANSWER**

1. What aspects you will look into regarding maintenance of cement concrete pavements ?  
[2017, 3 (c)]

Ans. The cement concrete pavement maintains a very high recognition among the engineer and the road users alike. Due to the excellent riding surface and pleasing appearance the cement concrete roads are very much preferred. Further the engineers have inherent confidence in the cement concrete materials for its use in any construction project. It is also true that the life of a cement concrete road is much more than any other type of construction. the cement concrete material exhibits its characteristics which can be predicted by classic theory and as such a structure made using this material can well be designed on a rational basis. This indirectly saves cost as the resultant structure gives an excellent performance.

The maintenance and repair if any required in cement concrete pavements are mostly associated with joints. A minimum period of 28 days curing is required before the cement concrete pavement could be opened to the traffic. The cement concrete pavements are constructed with or without the sub-base course.

## **CHAPTER - 08**

### **SHORT QUESTIONS ANSWER**

1. What do you mean by Road Pavers and Bulldozer ? [2015, 5 (a),2018,5a],2019 ,6(C)

Ans. The Paver unit is a compromise between a preumatic tractor and a dumper. At the site of work, necessary number of pavers and road rollers should be provided. Bulldozer is a equipment and it can be used for to clear the site of work, to make the land level.

2. Write a short note (Roller) [2016, 6 (c) iii]

Ans. Rollers :- The principle of rollers is the application of pressure, which is slowly increased and then decreased. The various type of rollers which are used for compaction are smooth wheel, pneumatic tyred and sheep foot rollers.

3. Define grader.2019 6(d)

A **grader**, also commonly referred to as a road **grader** or a motor **grader**, is a construction machine with a long blade used to create a flat surface during the grading process. ... Certain **graders** can operate multiple attachments, or be designed for specialized tasks like underground mining.

**4. Define traffic rotary. 2019-1(f)**

ANS:A circular arrangement of an intersection of two or more roads in order to facilitate the passage of vehicles from one road to another. Also [called r otary](#)

5. What do you mean by tack coat? 2019-1(j)

ANS: A tack coat is sprayed on the surface of an existing asphalt or concrete pavement by a distributor truck immediately prior to placing an overlay. The goal is to achieve uniform coverage over the entire surface to be paved.

## **CHAPTER - 09**

### **MEDIUM & LONG QUESTIONS ANSWER**

1. Classify traffic Island with neat sketches. [2015, 7 (b)] [2017, (3)]

Ans. Roundabouts are usually provided where the traffic density exceeds 500 vehicles (cars) per hour on all the intersecting roads. Some engineers recommend that rotaties should be provided at the crossings where right hand turn traffic is more than 50% or where the straight cross traffic is not more than 30% of the total traffic having density of more than 400 vehicle per hour. As a general guide a rotary is justified at the crossing where the right hand turning traffic exceeds 30% of all approaching traffic.

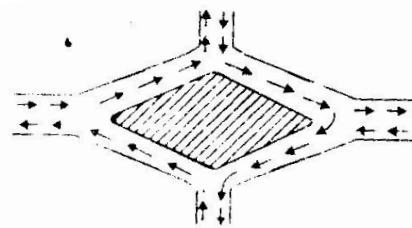
A rotary can handle efficiency about 3000 vehicles per hour under Indian traffic conditions.

The Indian Road Congress recommends the various vehicles to the passenger ar unit equivalent as follows :-

Passenger Car unit equivalents of various vehicles (I.R.C.)

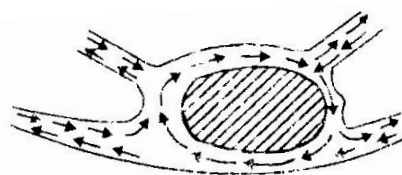
Shapes of Traffic Islands :- The islands may be circular, elliptical, rhombus, turbine shape or tangent shape.

1. Circular Island :- This is the best type of island and is suited when the two roads intersect, are of equal importance and width. As it has the shortest perimeter for a given area, the extra distance which the traffic has to travel is the minimum. It avoids the turns of short radius which hinder traffic.
2. Elliptical Island :- It is used where the traffic on one road is more than that on the other. The elongation is in the direction of the greater flow to facilitate thorough traffic.
3. Rhombus Island :- This is similar to elliptical island but instead of providing an ellipse, a rhombus type island is constructed on the same basis.



Diamond or Rhombus Island

4. Turbine Island :- In this type, the traffic is forced to slow down, when it enters the rotary, as it has to take a left hand turn and while leaving the rotary, it has a tangential exit.
5. Tangent Island :- In this case more than two roads enter a rotary and leave it tangentially. In this type of Island the thorough traffic is not obstructed and moves with a high speed. Such type of islands are very dangerous as there are chances of accidents.



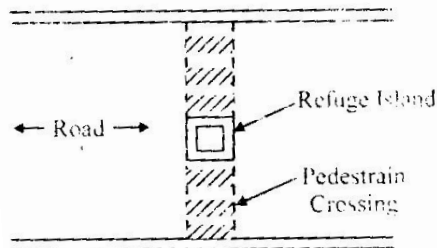
Tangent Island

Refuge Islands :- Refuge islands are safety islands and serve the dual purpose of affording protection to the pedestrians and segregating the traffic into its proper channels. These refuge islands are constructed in the centre of the wide roads, carrying a heavy volume of traffic and are a special boon for the aged and patients.

Refuge Islands are 15 to 20cm above the road level and are in the form of two triangular strips with a square one in between. The width of the island depends upon the width of carriage way.

The following are the advantages of refuge islands :-

- (i) It is a protection to the pedestrians
- (ii) It acts as a guidance to the drivers in negotiating on junctions.



- (iii) It increase the efficiency of traffic
- (iv) It segregates the traffic into proper channel

2. Write down the advantage and disadvantages of traffic signals. 2019 2(e)

Ans. Advantages of traffic signals the following uses.

- (i) They provide orderly movement of traffic and increase the traffic handling capacity of most of the intersections at grade.
- (ii) They reduce certain types of accidents, notably the right angled collisions.
- (iii) Pedestrians can cross the roads safety at the signalised intersection.
- (iv) The signal allow crossing of the heavy traffic flow with safety.
- (v) When the signal system is properly co-ordinated there is a reasonable speed along the maor road traffic.
- (vi) Signal provide a chance to crossing traffic of minor road to cross the path of continuous flow of traffic stream at reasonable intervals of time.
- (vii) The quality of traffic flow is improved by forming compact platoons of vehicles, provided all the vehicles move at approximately the same speed.

Disadvantages of traffic signals :-

- (i) The rear-end colisions may increase.
- (ii) Improper design and location of signals may lead to violations of the control system.
- (iii) Failure of the signal due to electric power failure or any other defect may cause confusion to the road users.

5. Explain with sketch how the obligatory points control the highway pavement ?

[2017, 2 (f)]

Ans. Obligatory Points - There are control points governing the alignment of the highways. These control points may be divided broadly into two categories.

- (i) Points through which the alignment is to pass.
- (ii) Points through which the alignment should not

- (i) Obligatory points through which the road alignment has to pass may cause the alignment to often deviate from the shortest or easiest path. The various examples of this category may be bridge site, intermediate town, a mountain pass or a quarry.

When it is necessary to cross hill range, mountains or high ridges the various alternative are to cut a tunnel across or to go round the hills or to deviate until a suitable hill pass is available. The suitability of these alternatives depend on many other factors, like the topography and site conditions and cost considerations. The straight alignment AB is deviated along the hill side pass, thus avoiding a tunnel or heavy cutting.

The road bridge across a river can be located only at place where the river has straight and permanent path and where the bridge abutment and pier can be properly founded. The road approaches to this bridge should not be curved near the bridge and as far as possible the skew crossing should be avoided. Thus in order to locate a bridge across a river the alignment may have to be changed. Figure shows that the straight alignment between stations A and B which passes across the river bend is to be deviated along the path shown in order to cross the river at a proper bridge location at the straight portion of the river on the upstream side of the bend.

- (ii) Obligatory points through which the road should not pass also may make it necessary to deviate from the proposed shortest alignment. The obligatory points which should be avoided while aligning a road include religious places, very costly structures, unsuitable land etc. Religious places like temple, mosques, church, grave or tomb have been protected by the law from being acquired for any purpose. Acquiring costly structures would mean heavy compensation resulting in increased cost. Marshy, peaty and water logged areas are generally unsuitable for road construction and should be avoided as far as possible. However if there, is no alternative and the alignment has to be taken across such an area the construction and maintenance costs are likely to be very high due to special construction techniques and drainage measures to be adopted.

A lake, a pond or a valley which falls on the path of a straight alignment will also necessitate the alignment to deviate from the straight path and go round along the grade line.

6. Discuss briefly the types of traffic signals.2019 2(e)

**ANS:** 1.Danger warning sign  
2. Priority sign  
3.prohibitory sign

- 4. Mandatory sign\
- 5. special regulation sign

## CHAPTER - 10

### QUESTIONS ANSWER

1. Define land scaping and arboriculture. [2015, 6 (a),2018,5(a)],2019 5(a)  
Ans. Land scaping is the improving the aesthetic appreance of an area by chanding its contaurs, adding ornamental features, or planting trees and shrubs.  
Abouriculture means the tree culture or carry and planting of trees.
2. Short Note :  
Aboriculture. [2019, 5 (a)2018,5(a)]  
Ans. The highway engineer with his inherent ingenuity and patience can achieve wonderful results with only small cost to beautify the road. Road arboriculture is one of the architectural effects, which adds to the general of overall appearance of the road. Arboriculture means tree culture, that is care and planting of trees.



**4<sup>TH</sup> SEMESTER**

**HIGHWAY ENGINEERING**

**TH-4**

*Er.D.Barik*