

DEPARTMENT OF CIVIL ENGINEERING
CE8604 HIGHWAY ENGINEERING
HIGHWAY PLANNING AND ALIGNMENT

PART- A (2 Marks)

1. Define central road fund?

On the recommendation of Jayakar Committee, a “Central Road Fund” came into existence on 1st march 1929, Upon the authority of a resolution adopted by the Indian legislature.

2. Define National Highway Act 1956?

In 1956, National Highway act was passed declaring the National Highways and empowering the central Govt. to declare any other highway to be NH. This act came into force with effect from 15th April 1957.

3. Explain CRRI?

CRRI- The central Road Research Institute Delhi in 1950 It is an council of scientific and industrial research, and in function include.

organ of the

4. Write Short notes on Highway Research Board?

This board was set up by I.R.C in 1973 to give proper direction and guidance to road research work in India.

5. What are classified roads in Nagpur plan?

1. National Highways (NH)
2. State Highways (SH)
3. District Roads:
 - (1) Major district Roads
 - (2) Other district Roads
4. Village roads.

6. Define Express ways?

These roads are of higher, day than National highway. There are Such roads on which only font moving vehicles like car and jeeps are classified.

7. What are the modified classifications of Road system by Third RDP (1981-2001)?

1. Primary System
2. Secondary System
3. Tertiary system

8. What are types of Road patterns?

1. Rectangular (or) Black pattern.
2. Radial (or) Star and black pattern.

9. Write short notes or Nagpur plan (or) its 20-year Road plan.

The first attempt for proper Scientific planning of roads in India, Wan made in chief Engineers conference held at Nagpur in 1943. Nagpur conference finalized at 20 years (1943-1963) road development plan.

10. Write short notes on Second twenty year road plan (1961-81)

A Second road development programmer (1961-81) was finalized by the chief engineers connected with road development, both at centre and Staten in a meeting held at Hyde Chad in 1959.

11. What are the fundamental principles of alignment?

1. Length of road should be shortest
2. The Proposed road should form a most economical line.
3. The alignment should provide corny.

12. What are the functions which control the selection of alignment?

1. Volume and type of traffic
2. Obligatory points
3. Canal river (or) railway crossings
4. Geotechnical standard to be adopted

13. Define obligatory point?

Obligatory points are such points which act to control points in highway alignment.

14. What are special considerations for highway road alignment?

1. Stability
2. Drainage
3. Geometric standard
4. Deep cutting and heavy fillings should be avoided.

15. What are the various types of engineering surveys?

1. Map study
2. Reconnaissance survey
3. Preliminary survey
4. Detailed Survey

16. What are two types of road project?

1. A new highway Project
2. Re-alignment (or) re-opening Highway project

17. What are factors involved in Highway Geometric?

1. Cross Section elements like camber, Super elevation
2. Sight distance characteristics like stopping sight distance, overtaking sight distance etc.
3. Horizontal and vertical alignments

18. Define camber?

Transverse slope given to the road surface is called camber. It is provided mainly to drain off rain water from the road surface.

19. What are the factors depend on camber?

1. Account of Surface
2. Type ground surface

20. What camber recommended in WBM Road?

Water Bound Macadam road 1 to 33 (3%) 1 in 40 (2.5%).

21. What camber recommended in bihiminour road?

Bihiminour surface 1 in 40 (2.5%) 1 in 50 (2%)

22. What camber recommended in cement concrete Road?

Cement concrete Road 1 in 50 (2%) 1 in 60 (1.7%)

23. What are the different types of camber?

1. Parabolic camber
2. Sloped camber
3. Composite camber

24. Define carriage way width?

Metal led puce strip of road meant for vehicular traffic movement in called carriage way.

25. Define dual carriageways?

Each portion of the carriageway is reserved for traffic moving in opposite direction. Such carriage ways are called dual carriageways.

26. What are the width of carriage way in meteor two lane without raised wert state highways?

State highways 7.0 m

27. Write note on high speed barrier herb?

This herb is 23cm to 45cm to height. This herb is mainly used at initial location such as bridge and hill roads.

28. Define formation width?

Formation width is also called road way. It is the sum of width of carriage way shoulders, and separations it provided

29. Define Right of way:-

Area to the acquired along the road alignment in called right of way.

30. What are the important modifications made in Macadam's method with respect to the other methods?

Following are the important modifications made in Macadam's method.

- i) Realizing the importance of subgrade drainage and compaction, the subgrades were prepared with sufficient cross slope.
- ii) Heavy foundation stones were replaced with broken stones and with adequate drainage arrangements.
- iii) The total thickness is comparatively less and the order of 25 cm.
- iv) The size of broken stones used for the layer was based on the stability under animal drawn vehicles.

31. What are the objectives of Central Road Fund?

As per the recommendation of Jayakar Committee, a "Central Road Fund" was created in 1st march 1929. The Consumers of petrol were then charged an extra levy of 2.64 paise per litre (i.e., two annas per gallon). Twenty percent of the revenue collected through the fund was retained as Central Reserve and the balance allotted to the various states based on the actual petrol consumptions.

32. State the principles of highway financing.

Highway financing is concerned with the sources and distribution of the money that is obtained for highway purposes. Thus the basic principle in highway financing is that the money spent on the construction and maintenance must be recovered from the roads users.

33. Mention the functions of medians in urban roads.

Separators or medians are provided to prevent the head on collision between two vehicles moving in opposite directions in the adjacent lanes. These medians may be in the form of pavement markings, physical dividers or area separators. Out of these three pavement making is the respect.

PART – B (16 Marks)

1. (i) State the construction steps of Macadam method of road formation.
(ii) Compare with Telford road construction.
2. How urban and rural roads are classified? Explain.
3. State and explain the various types of kerbs.
4. (i) What are the requirements of an ideal highway alignment? Discuss briefly.
(ii) Compare Conventional methods with modern methods in Highway.
5. (i) Discuss in detail about the obligatory points controlling highway alignment.
(ii) Explain
 1. GIS
 2. GPS
 3. Remote sensing
 4. Total station
6. Define MORTH. Write the importance of MORTH.
7. (i) Briefly explain the role of MORTH and IRC in highway development.
(ii) State and explain the economic factors influencing highway alignments.
8. Draw typical cross sections of urban and rural roads.
9. Draw a neat sketch and explain the cross section of an urban arterial.
10. With a neat sketch explain the cross-sectional elements of a 2 lane rural road on embankment.
11. Write the salient features of Nagpur Road plan.
12. Describe the various steps in a highway project.
13. Explain the different components of the National Highway Development Programme (NHDP).
14. Describe the classification of urban roads in India. Give the cross section of urban Arterial Street with all its features.
15. (i) Explain the activities of National Highway Authority of India.
(ii) Explain the procedure for carrying out road alignment using remote sensing and GIS technique.
16. Compare the three “Twenty year road development plan” in India. Also discuss the merits of each one of them.
17. Explain in detail about second twenty year road plan.
18. Write a brief notes on:
 - a. Central Road Fund (CRF).
 - b. Indian Roads Congress (IRC).
 - c. Motor vehicle act.
 - d. Central Road Research Institute (CRRI).
 - e. Highway Research Board (HRB).
 - f. Nagpur road plan.
 - g. National Highway Authority of India (NHAI).

UNIT-II

GEOMETRIC DESIGN OF HIGHWAYS

PART- A (2 Marks)**1. Define sight distance?**

Sight distance is the actual length of road over which a driver sitting at a specified height in a vehicle can see objects either moving (or) stationary on the road surface.

2. What are classifications of sight distance depending upon the situation?

1. Stopping sight distance
2. Sate overtaking sight distance
3. Sight distance at intersection

3. Define S.S.D?

Stopping sight distance is the minimum distance required with in which a vehicle moving at designed speed can be stopped without colliding with a stationary object on the road surface.

4. What is the height of driver eye above the road surface?

IRC recommended height of driver eye is 1.22m.

5. Define reaction time:-

It is the time in seconds which a driver can take from the instant the objects visible to him to the instant the brakes are effectively applied.

6. Define perception period?

Perception period is the time taken by an average driver to realize a danger a head before actually trying to apply the breaker.

7. Define overtaking sight distance (OSD)

The distance visible to the driver of a vehicle intending to overtake another slow moving vehicle, without causing any inconvenience (or) possibility of accident to the traffic in the opposite direction in called overtaking sight distance (or) safe passing sight distance.

8. Define design speed?

Design speed can be defined as the speed which is permissible for safe and comfortable driving on a given surface of the highway.

9. What are the two effects of centrifugal force?

1. Tendency to overturn the vehicle.
2. Tendency to skid the vehicle laterally.

10. Define super elevation?

The outer edge of the road is raised above the inner edge called super elevation (or) cant (or) banking.

11. What is the relation between super elevation, coefficient of friction and centrifugal force

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

e = super elevation whose value is taken as 40 (or) 1/15

f = Lateral frictional coefficient whose value is

R = Radius of curve in metres.

g = 9.8

V = speed of vehicle in m/sec.

12. What is the maximum rule of super elevation?

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

This formula assumes that centrifugal force corresponding to 75% of the designed speed is balanced by super elevation and the rest is acted by the side friction.

13. Define horizontal curve?

It is a curve in plan to provide change in the direction of the central line by the road surface.

14. What are the factors attesting the design of curve?

1. Design speed of the vehicle
2. Allowable friction
3. Maximum allowable super elevation.
4. Permissible centrifugal ration.

15. Define vertical curve?

It is a curve in the longitudinal section of a highway to provide a easy change of the gradient.

16. What are curve used in a highway.

1. Circular curve
2. Transition curve
3. Parabolic curve

17. What is the value of radian of the simple curve?

$R = 1720m$ app

18. Define compound curve?

A compound curve currish of a serial of hoot (or) more simple curve that run in the same direction and joint at common tangent point.

19. Define Reverse curve?

A reverse curve consist of two simple curve opposite direction that point at the common tangent point. This common point in called the point of reverse curve

20. What are the types of transition curve?

1. True spiral (or clothed).
2. cubic spiral.
3. cubic parabolic.
4. Lemniscate's.

21. What are characteristics of Transition curve?

1. It should meet the straight path tangentially
2. It should meet the circular curve tangentially

22. What is the equation of a spiral transition curve?

$$L_s = m \ddot{O} Q$$

Where $m = \ddot{O} 2RL = \text{a constant}$

$Q = \text{tangent of deflection angle in radians}$

23. How many methods to determine the length of transition curve?

- (1) By the rate of change of radial acceleration
- (2) By empirical formula

24 . Define gradient?

It is the rate of rise (or) fall of road level along if length

25. What are the factors governs the gradient?

- (1) characteristics – of the traffic.
- (2) Physical factors of the site such a drainage, safety,
- (3) Bridge, approach Road and railway Line intersection etc.

26. What are different types of gradient?

- (1). Maximum gradient
- (2). Puling gradient
- (3). Limiting gradient
- (4). Exceptional gradient

27. What are the driaclvantager of Exceptional gradient?

- (1). More fuel consumption
- (2). More friction losses
- (3). Efficiency of engine reducer
- (4). Early fatigue to animals.

28. What are the hyper of vertical curve?

1. Summit curve
2. Valley curve

29. what is the minimum Radian of vertical curve?

The minimum ration of the curve is given by

$$R = \frac{L}{Q}$$

30. What is the length of valley curve?

$$L = 0.38 (NV 3)^{\frac{1}{2}}$$

$L = \text{Total Length of valley curve}$

$N = \text{Deviation angle}$

$v = \text{Design speed in triumph}$

PART – B (16 Marks)

1. What are the objectives of widening of road pavement at horizontal curves? Derive an expression for the extra widening
2. (i) The speed of overtaking and over taken vehicles are 70 and 40 kmph, respectively on a two way traffic road. If the acceleration of overtaking vehicle is 0.99m/sec^2
 - a. Calculate safe overtaking sight distance
 - b. Mention the minimum length of overtaking zone and
 - c. Draw a neat-sketch of the overtaking zone and show position of sign posts.
- (ii) What is overtaking sight distance and intermediate sight distance?
3. (i) Derive the formula for the radius of horizontal curve.
(ii) Why do you provide the extra widening on horizontal curves?
4. Describe the various types of horizontal curves.
5. Under what circumstances summit curves are provided.
6. What are the objectives of providing transition curves in the horizontal alignment of highway curves? Mention the method of designing transition curve length.
7. What are the objectives of widening of road pavement at horizontal curves? Derive an expression for the extra widening.
8. What are the objects of extra widening of pavements at horizontal highway curves? Mention the recommended method of design and introduction in the field.
9. A valley curve is formed by a descending gradient of 1 in 25 meeting an ascending gradient of 1 in 30. Design the length of valley curve to fulfill both comfort condition for a design speed of 80 kmph ($c = 0.6 \text{ mtr/sec}^3$) and a head sight distance of 127 m for this speed.
10. (i) Compute the stopping sight distance on a highway with a design speed of 80 kph, if the highway is on an upgrade of 2%.
(ii) Outline the design elements of hill roads.
11. (i) What is the need for transition curve? How its length is determined?
(ii) Explain the procedure for calculating the length of valley curve.
12. (i) Explain the factors influencing the geometric design of hill roads.
(ii) Calculate the SSD for design speed of 70 kmph for two way traffic and one way traffic road. Take reaction time = 2.5 seconds and coefficient of friction = 0.35.

13. (1) Derive the formula for calculating super elevation on horizontal curve.
(2) Explain the factors influencing overtaking sight distance
14. Calculate the stopping sight distance required to avoid head on collision of two cars approaching from opposite directions at a speed of 75 kmph and 80 kmph. Assume that the reaction time of drivers be 2.5 secs and coefficient between road surface and tyres be 0.4.
15. (i) Distinguish between overtaking sight distance and intermediate sight distance. How will you calculate these?
(ii) What is the super elevation to be provided on a horizontal curve on a National Highway in plain terrain (Hint: Design speed =100 kph), if the curve has a radius of 310 m?
16. (i) Why is super elevation provided for pavements in curves? Explain the factors influencing it.
(ii) Why are extra widening of pavements required in curve?
17. (i) Calculate the stopping sight distance for the design speed of 60 kmph for a two-way traffic road and an one-way traffic road, Take the reaction time of driver as 2.5 seconds and the coefficient of friction as 0.36.
(ii) Under what circumstances summit curves are provided.
18. (i) Calculate the stopping sight distance to avoid head on collision of two cars approaching from opposite directions at 100k/hr and 80 k/hr. Make suitable assumptions.
(ii) A highway width 7.5 m of radius 150 m, with a speed of 130 km/hr and the length of wheel base is 7.0 m. Find out the extra widening required.
19. Calculate the stopping sight required to avoid head on collision of two cars approaching from opposite directions at a speed of 75 kmph and 85 kmph. Assume the reaction time of drivers be 2.5 secs. And the coefficient of friction between road surface and tyres is 0.4.
20. Calculate the minimum set back distance required on a two lane highway curve radius 400 m so as to provide an intermediate sight distance 180 m , assuming the length of the curve to be greater than SD (200 m).
21. A valley curve is formed due to two gradients +2.5% and -1.75%. If the design speed of this highway is 80 kmph, determine the stopping sight distance and design the valley curve to fulfill both comfort and head light sight distance conditions.

UNIT-III

FLEXIBLE AND RIGID PAVEMENTS

PART- A (2 Marks)

1. What are the materials required for W.B.M roads?

1. Coarse aggregate.
2. Screenings.
3. Filler materials

2. What are types of bituminous road?

1. Surface dressing
2. Bituminous bound macadam

3. Define seal coat?

Premixed seal bitumen (or) surface dressing type seal coat is applied either immediately (or) after a few days.

4. What are methods adopted for construction of cement concrete pavement?

1. Cement grout method
2. Rolled concrete method.
3. Cement concrete slab method

5. What types of joints are provided in cement concrete pavements?

1. Expansion joint
2. Contraction joint
3. Warping joint.

6. What material used as joint Filler?

1. Soft wood
2. Impregnated fiber board
3. Cork (or) cork bound with bitumen
4. Coir fiber

7. What material used as joint sealer?

1. Bitumen
2. Rubber bitumen

8. Write short notes on Hair pin bend?

A hair pin bend should be located on the hill side having the minimum slope and maximum stability. It should be safe against land slide and ground water. Hair pin bends with long arms and further spacing should be provided.

9. What are the methods of pavement?

1. Flexible pavement
2. Rigid pavement

10. What are the components of a flexible pavement?

1. Soil sub grade
2. Sub base course
3. Base course
4. Wearing course

11. Define sub grade?

The soil sub grade is a layer of natural soil prepared to receive the other layers of the pavement.

12. What properties posses soil sub grade?

- a. strength
- b. Drainage
- c. Ease of compaction
- d. permanency of compaction etc.

13. What are tests conducted the strength properties of the sub grade?

- 1. California bearing ratio tests
- 2. California resistance value test
- 3. Plate bearing test
- 4. Trysail shear test

14. Define bone course?

It is the foundation layer, designed for the structural stability. The main function of the bare course in edible pavements is to improve the load supporting capacity by distributing the load through a finite ethicalness.

15. Define leaving course?

It is that component of pavement with which the wheels of vehicular are in archival contain.

16. What are the factors attaching stability of pavement?

- a. Traffic factors.
- b. Mosher factors.
- c. Climatic factors.
- d. Soil factors
- e. Stets dissipation factors.

PART – B (16 Marks)

1. Briefly give the IRC Recommendations useful in the design of cement concrete pavement.
2. Explain in detail about the IRC method of flexible pavement design. Discuss limitation of this method.
3. Explain the methods of design of Flexible pavement by CBR method.
4. Discuss the advantage and limitations of CBR method of design.
5. Differentiate between Flexible and rigid Pavement (or) Compare Flexible and Rigid Pavement.
6. Explain the design consideration for spacing of expansion and construction Joints.
7. What are the objectives of joints in cement concrete pavement? Sketch the different types of joints used in pavement construction. Indicate the principle of design.
8. Explain mud pumping. What are the causes for mud pumping and how it can be prevented?
9. Define ESWL and Lane distribution factor and explain their significance.
10. Describe the factors influencing the design of pavements.
11. Explain the recommended design procedure for design of rigid pavements by IRC.
12. List the different stresses induced in cement concrete pavements. Discuss the critical combination of these stresses.
13. How will you calculate the Equivalent Single Wheel Load for a given combination of wheel loads?
14. Explain the IRC method of design of rigid pavements.
15. Explain the factors to be considered in the design of pavements.
16. State how variations in climatic conditions affect the design of pavements.
17. What is equivalent single wheel load? Explain briefly.

18. Design the pavement of a plain cement concrete 7m wide. Use IRC Recommendations where ever applicable. Adopt expansion joint gap 20mm and Maximum variation in temperature between summer and winter is 40°C . Present Traffic intensity is 1050 veh/day of weight more than 3T. Modulus of reaction of sub base 7 kg/cm^3 . E for concrete = $3 \times 10^5 \text{ kg/cm}^2$, $\mu = 0.15$ and radius of contact area is 15 cm and design wheel load is 4100 kg. Temperature differential slab in the region is 17.3, 19.0 and 20.3 for thickness is of 15, 20 and 25cm respectively. (use design chart if necessary)
19. CBR value of sub grade is 4%. Calculate total thickness of pavement. Also calculated the thickness of sub base, base, wearing layer having CBR value of 15%, 80%, and 90% respectively. Use IRC accepted CBR curve 'D'. (Use design chart)
20. Using the following data, design the flexible pavements layers
- CBR of the sub-grade soil = 5%
 - CBR of poorly graded gravel sub-base = 15%
 - CBR of WBM = 80%
 - Design life = 15 years
 - Annual rate of increase in the heavy vehicles = 7.5%
 - No. of heavy vehicles per day during last count = 200
 - No. of years between the year of completion and year of last count = 3 years.
- Assume any other data found required
21. Design the flexible pavement for construction of new Highway with the following data.
- Number of commercial vehicles as per last count = 1000
 - Period of construction = 3 years
 - Annual traffic growth rate = 8%
 - Category of road = NH, two lane single carriageway
 - Design life = 10 years.

UNIT – IV

HIGHWAY MATERIALS AND CONSTRUCTION PRACTICE

PART- A (2 Marks)**1. Define contact presume?**

$$\text{Contact presume} = \frac{\text{load on wheel}}{\text{Contact area}}$$

2. Define Rigidity factor?

$$\text{Rigidity factor} = \frac{\text{contact presume}}{\text{Type presume}}$$

3. What is ESUL?

Equivalent Single Used Load

4. What understand by Repetition of load?

The repeated loading may produce permanent and non uniform deformation of sub grade.

5. What are the causes of increase in moisture?

1. Percolation of surface water through Erath in the pavement surface.
2. Entry of water through edger of the pavement
3. Seepage
4. Capillary rise from high water table

6. What is meaning of frost heave?

The terms frost heave return to rising up of the pavement portion.

7. What method is used for strengthening of flexible pavement?

Benkelman Beam Reflection method.

8. What is the basic principle of Benkelman Beam deflection method?

The deflection method is based on the concept that pavement section which have been conditioned by traffic elastically under a load.

9. What are the factors considered deformation under a given load?

1. Sub grade soil type
2. Soil mousier content and its compaction
3. Thickness of pavement layers
4. Drainage conditions.

10. What are factors causing stressor in slab?

1. Used loads
2. Cyclic changer in temperature
3. Changes in moisture
4. Volumetric changer in bare course.

11. Define hand aggregator give example?

Hand aggregator are used to resist crushing effect and adverse weather effect (ex) granite trap

12. What is the user of soft aggregator?

They can also be used in lower layer of good type of roads. Soft aggregator are usable in low cost road.

13. What are the proportions of aggregator?

1. Strength
2. Hardness
3. Toughens
4. Sound ness
5. shape of aggregate
6. Bushmen adhesion properly
7. Cementations

14. What are test for Road aggregator?

1. Abrasion test
2. Lost angler abrasion test

15. Define Elongation index?

This test is also suitable for aggregate of size greater than 6.3mm and is carried out in the same way as has been explained in flakiness index

PART – B (16 Marks)

1. Write down the construction steps for water bound macadam road. Explain with sketch.
2. Describe the construction steps for surface dressing (or) Bituminous concrete methods of Bituminous construction with sketch.
3. Enumerate the steps in the construction of cement concrete pavement. Explain with sketch.
4. Write short notes on (a) CBR test on soil (b) Field density test on soil.
5. Explain with sketch the following testing methods.
 - (a) Penetration test on Bitumen (b) Softening point test on Bitumen
 - (or) Briefly explain the penetration test and softening point test on Bitumen.
6. Explain with neat sketch of impact value test on aggregates.
7. Explain with neat sketch of Durability test on Bitumen.
8. Explain with neat sketch of Los angel's abrasion testing method of Road aggregates.
9. Explain with neat sketches how the subsurface drainage system is provided to lower the water table and control seepage flow.
10. Explain briefly with sketches "Drainage in Hill Roads"
11. Explain briefly "crushing strength" test on Road aggregates with sketches

12. Describe how impact value of aggregate and specific gravity of bitumen are found by experiment in laboratory?
13. Distinguish between impact and abrasion values of aggregate. How are these values measured?
14. What is WBM? Describe the construction procedure of a WBM road.
15. Distinguish between viscosity and softening point of road bitumen. Describe their test procedures.
16. Discuss the importance of surface and sub-surface drainage in highways.
17. What are the desirable properties of road aggregates? Explain briefly.
18. Write a note on aggregate impact test.
19. Write short notes on the following:
 - (i) Crushing Test
 - (ii) Water Absorption Test
 - (iii) Ductility Test
 - (iv) Viscosity Test.
20. Describe how impact value of aggregate is found in laboratory.
21. Explain the test procedure for assessing polishing value of aggregate.
22. Explain the construction procedure of dense bituminous macadam road.
23. Describe the procedure recommended by bureau of Indian standards for carrying out the following tests.
 - a. Abrasion Test
 - b. Flash and Fire point test
24. Specify the design approach for the surface drainage system of highways.
25. Explain the construction procedure for bituminous concrete.
26. Describe how impact value of aggregate and specific gravity of bitumen are found by experiment in laboratory?
27. Explain the construction procedure of the following types of roads.
 - (i) Dense Bituminous Macadam.
 - (ii) Bituminous Concrete.

UNIT – V

HIGHWAY MAINTENANCE

PART- A (2 Marks)

1. What are the proportions of bituminous material?

1. Consistency
2. Durability

2. What are test of bitumen?

1. Generation test
2. Ductility test
3. Solubility test

3. What are different grade of bitumen?

30/40, 80/100, 60/70

4. Define emulsion?

Emulsion is a combination of water bitumen and an emulsifying agent.

5. What are test for bitumen emulsion?

1. Sieve test
2. Mining test

6. What are general causes of pavement failure?

1. Faulty material of commotion
2. Faulty construction and improper quality control during construction.

7. What are typical failover of flexible pavement?

1. Shear failure
2. Longitudinal cracks.

8. What is typical failure of cement concrete pavements?

1. Mud pumping
2. Spelling of joint

9. What are the classifications of maintenance?

1. Routine maintenance (or) repairs
2. Periodic maintenance
3. Special repairs.

10. What are two methods of pavements evaluation?

1. Structural evaluation of pavement
2. Evaluation of pavement surface conditions.

PART – B (16 Marks)

1. Discuss the various types of failure in Flexible pavement? Explain the causes. (or)
Classify the different types of failures in flexible pavement and mention the important causes of each. (or)
Discuss with the help of sketches the different types of failures in flexible pavements.
2. Discuss briefly the different types of failures in rigid pavement.
3. List the causes of failure in cement concrete pavements. What are the effects of different types of failure?
4. Write short notes on the following.
 - a) Mud pumping.
 - b) Alligator cracks.
 - c) Consolidation deformation.
 - d) Pavement evaluation.
5. (i) Explain the different types of evaluation of pavement surface condition
(ii) Explain the causes and remedial measures for surface rut.

6. Describe the symptoms, causes and remedial measures for the different types of failures in flexible pavements.
7. Briefly explain the procedure of overlay design by Benkelman beam method.
8. Explain how resealing of cracks may be carried out in rigid pavements.
9. Explain any two commonly employed methods for the structural evaluation of flexible pavements.
10. Explain briefly the maintenance of bituminous surface.
11. What is meant by rutting? Explain the symptoms, causes and treatment.
12. Explain the procedure for the structural evaluation of pavements.
13. (i) What are the different types of failures in cement concrete pavements?
(ii) What are flexible overlays? Explain how the Benkelman Beam is used to design the thickness of the overlay.
14. (i) Explain the principle and uses of Benkelman Beam test.
(ii) Describe the complete procedure of carrying out Benkelman Beam test to evaluate the pavement with model calculation.
15. Write short notes on the following.
 - a. Stripping and raveling
 - b. Structural cracks and temperature cracks.
 - c. Longitudinal cracking and reflection cracking.
 - d. Mud jacking and Overlay thickness.
16. Write a critical note on the maintenance of following roads.
 - a. Earthen roads
 - b. Gravel roads.
 - i. C. W.B.M roads
 - c. Cement concrete roads.
17. Discuss the following procedure for Flexible pavement evaluation
 - (a) Benkelman beam deflection studies.
 - (b) (i) Estimation of Unevenness Index.
(ii) Pavement serviceability Index.
(iii) Present serviceability Rating.
(iv) Highway financing