

DHANALAKSHMI SRINIVASAN
COLLEGE OF ENGINEERING AND TECHNOLOGY, MAMALLAPURAM
DEPARTMENT OF CIVIL ENGINEERING -QUESTION BANK

CE 6504 HIGHWAY ENGINEERING

Unit 1(Part A)

MOST IMPORTANT QUESTIONS

1. What are the special features of Roman roads?
 - They were built straight without any gradient.
 - The soft soil from the top was removed till the hard stratum was reached.
 - The total thickness of road section was around 750mm to 1200mm.

2. What are the important modifications made in Macadam's method of road construction?
 - The total thickness of foundation was 250mm.
 - Smaller foundations stones are provided.
 - A cross slope of 1 in 36 was adopted from the subgrade.

3. What are the main factors for consideration in third twenty year road development programme?
 - Growth of Industry and agriculture
 - Requirements of hills, deserts and coastal areas
 - Expansion of tourism
 - Rural and Urban development
 - Environmental consideration

4. Write a short note about National Transport Policy Committee.
 - It was formed by central government in 1978 to prepare a comprehensive national transport policy for the country.
 - Report was submitted in 1980.
 - Major recommendations in the report are accepted by central government.

5. What are the objectives of highway research board?
 - To collect and analyze results on research
 - To coordinate and conduct the correlation services in transport research
 - To evaluate the nature and extend of research required.
 - To regulate the consultive services

6. State the names of various patterns of the road.
 - Rectangular or block pattern
 - Radial or star block pattern

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- Radial or star circular pattern
- Radial or star grid pattern
- Hexagonal pattern
- Minimum travel pattern

7. What are the principles of highway financing?

- Benefits from the highway construction
- Cost of the highway transportation
- Funds recovered from road users

8. What are the methods of raising highway finances?

- Pay-as-you go method
- Credit financing method

9. Mention the functions of medians in urban roads.

- To avoid the head-on collision between vehicles moving in opposite direction
- To channelize the traffic in to streams at intersections
- To provide protection for pedestrians
- To separate slow moving traffic

10. What is BOT project?

- BOT means Build, Operate and Transfer.
- It is public private partnership model where a private organization is given responsibility of construction and operation of roads and then the control is transferred to the government

Unit 1 (Part B)

MOST IMPORTANT QUESTIONS

1. Describe the requirements of ideal highway alignment (Nov / Dec 2011), (May/ June 2013)
2. Explain the different components of the National Highway Development Programme (NHDP) (Nov / Dec 2011)
3. What are the three obligatory points and illustrate with neat sketches how they control highway alignment (Nov / Dec 2013)
4. Draw the classification of urban roads with a neat diagram (Apr/ May 2014), (May/ June 2013)
5. Explain in detail about Second twenty year road plan .Also discuss the merits of each one of them (Apr/ May 2010), (May/ June 2012)

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Unit 2 (Part A)

1. What is meant by non-passing sight distance?

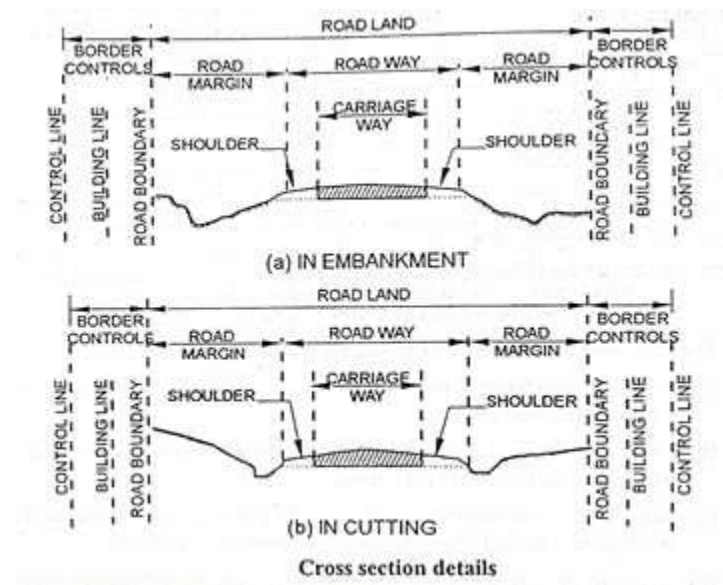
The minimum distance visible to a driver ahead or the sight distance available on a highway at any spot should be of sufficient length to safely stop a vehicle travelling at design speed, without collision with any other obstruction. Therefore this stopping sight distance (SSD) is also called absolute minimum sight distance. This is also sometimes called non-passing sight distance.

2. Write the requirements of an ideal transition curve.

The requirements of an ideal transition curve are,

- a) Length of transition curve
- b) Radius of the circular curve
- c) Total deviation angle
- d) Tangent deviation angle of the transition
- e) Central angle of circular arc
- f) Tangent distance
- g) Apex distance

Draw a typical cross section of a four lane divided National Highway and indicate width of carriageway, shoulders and right of way



4. Calculate the ruling minimum radius of a horizontal curve of a National Highway in plain terrain. Assume design speed = 80 kmph and super elevation = 0.07 and coefficient of friction = 0.15

Ruling minimum radius, $R_{\text{ruling}} = V^2 / 127 (e + f)$
 $= 100^2 / 127 (0.07 + 0.15)$

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= 357.9 m say 360 m

5. What are the functions of transition curves?

The functions of transition curves are,

- a) To introduce gradually the centrifugal force between the tangent point and the beginning of the circular curve, avoiding a sudden jerk on the vehicle
- b) To enable the driver turn the steering gradually for his own comfort and safety

6. What is meant by minimum gradient?

The road can be level, with little or no gradient. In such cases there will be problems of drainage. Though the surface water can be drained off to the side drains by providing proper camber on the pavement surface and cross slope on the shoulders, a certain longitudinal slope is essential, to drain the water along the side drains depending on the surface of the drains. The gradient with minimum slope for the purpose of drainage along the side of the road is known as minimum gradient.

7. What are the factors on which stopping sight distance depends on?

The factors on which stopping sight distance depends on are,

- a) Total reaction time of the driver
- b) Speed of vehicle
- c) Efficiency of brakes
- d) Frictional resistance between the road and the tyres
- e) Gradient of the road

8. State the objectives of providing transition curves in Highways.

The objectives of providing transition curves in highways are,

- a) To avoid a sudden jerk on vehicle
- b) To improve the aesthetic appearance of the road

9. What is meant by superelevation?

In order to counteract the effect of centrifugal force and to reduce the tendency of the vehicle to overturn or skid, the outer edge of the pavement is raised with respect to the inner edge, thus providing a transverse slope throughout the length of the horizontal curve. This transverse inclination to the pavement surface is known as superelevation or cant or banking.

10. Define – Stop Sighting Distance

The minimum distance visible to a driver ahead or the sight distance available on a highway at any spot should be of sufficient length to safely stop a vehicle travelling at a design speed, without collision without any other obstruction. This is known as stop sighting distance

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Unit 2 (Part B)

MOST IMPORTANT QUESTIONS

1. List the different stress induced in cement concrete pavements. Discuss the critical combination of these stresses(**Nov / Dec 2011**)
2. Explain the CBR method of design of flexible pavements (**Nov / Dec 2011**)
3. How will you calculate the Equivalent Single Wheel Load for a given combination of wheel load (**Nov / Dec 2011**)
4. Explain the IRC method of design of rigid Pavement (**Nov / Dec 2011**)
5. Design the flexible pavement for the construction of a new highway with the following data: (**Nov / Dec 2013**)
 1. Category road = Four lane dual carriageway
 2. Number of commercial vehicle in the year of completion of construction = 5600 commercial vehicle per day per direction
 3. Annual growth rate of commercial vehicles = 8%
 4. Design life = 15 years
 5. Design of CBR of sub grade soil = 5%
6. Explain the following concepts with reference to the design of flexible pavements
a) Lane distribution factor b) Vehicle Damage factor (**Nov / Dec 2013**)
7. State the difference between Flexible and rigid Pavements. And discuss the material components of both (**Apr/ May 2014**)
8. Design the flexible pavement for the construction of a new highway with the following data: (**Apr/ May 2014**)
 1. Category road = Four lane single carriageway
 2. Number of commercial vehicle in the year of completion of construction = 3200 commercial vehicle per day per direction
 3. Design life = 15 years
 4. Design of CBR of sub grade soil = 10%
 5. Period of construction = 4 Years
 6. Category of road = NH. Assume the suitable data
9. Explain the function of the components of flexible pavements (**May/ June 2013**)
10. Explain the factors governing the structural design of pavements (**May/ June 2013**)

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UNIT-2

1. Define Pavement?

The Pavement consisting of a few layers of Pavement material is constructed over a prepared soil sub grade to serve as a carriageway. One of the objectives of a designed Pavement is to keep this elastic deformation of the Pavement within the Permissible limits

2. What are the types of Pavement Structure?

Based on the structural behaviour, Pavements are generally classified in to two categories.

- i) Flexible Pavements.
- ii) Rigid Pavements.

3. What is mean by Flexible Pavements?

Flexible Pavements are those, which on the whole have low or negligible flexural strength and are rather flexible in their structural action under the loads. The Flexible Pavements layers reflect the deformation of the lower layers on to the surface of the layer.

4. What are the components in Flexible Pavements?

A typical flexible pavement consists of four components

- i) Soil sub grade
- ii) Sub base course
- iii) Base course
- iv) Surface course

5. Define rigid pavement.

Rigid pavements are those, which possess note worthy flexural strength or flexural rigidity. The stresses are not transferred from grain to the lower layers as in the case of flexible

6) What are the functions are in pavement components?

The functions are:

- 1) Soil subgrade and its evaluation
 - a. California bearing ratio test
 - b. California resistance value test
 - c. Triaxial compression test
 - d. Plate bearing test.
- 2) Sub base and base courses and their evaluation
- 3) Wearing course and its evaluation

7) Define the two parts of pavement design?

Pavement design consists of two parts:

- i) Mix design of materials to be used in each pavement component layer

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ii) Thickness design of the pavement and the component layer.

8) What are the factors considered in design of pavements?

The various factors to be considered for the design of pavements are given below.

- i) Design wheel load
- ii) Sub grade soil
- iii) Climatic factors
- v) Pavement component materials
- v) Environmental factors
- vi) Special factors in the design of different types of pavements.

9. Define – Camber

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

10. What are the factors to be considered for hill road alignment?

The factors to be considered for hill road alignment are,

- a) Stability
- b) Drainage
- c) Geometric standard
- d) Deep cutting and heavy fillings should be avoided.

11. Define – Sight Distance

The geometric design of the road should be done such that any obstruction on the road length could be visible to the driver from some distance ahead. This distance is said to be the sight distance.

12. What are the types of sight distance?

The types of sight distance are,

- a) Stopping sight distance (SSD) or the absolute minimum sight distance
- b) Intermediate sight distance (ISD) is defined as twice SSD
- c) Overtaking sight distance (OSD) for safe overtaking operation

PART-B

1. With a neat sketch explain the cross-sectional elements of a 2 lane rural road on embankment.
2. Draw typical cross sections of urban and rural roads.
3. What are the factors affecting geometric design?
4. Derive the equation for sight distances.
5. The speed of overtaking and overtaken vehicles are 70 and 40 kmph, respectively on a two way traffic road. If the acceleration of overtaking vehicle is 0.99 m/sec^2 . Calculate SSD, OSD and ISD

UNIT – III

Two Marks Questions and Answers

1) Define Pavement?

The Pavement consisting of a few layers of Pavement material is constructed over a prepared soil sub grade to serve as a carriageway.

One of the objectives of a designed Pavement is to keep this elastic deformation of the Pavement within the Permissible limits.

2) What are the types of Pavement Structure?

Based on the structural behaviour, Pavements are generally classified in to two categories.

- i) Flexible Pavements.
- ii) Rigid Pavements.

3) What is mean by Flexible Pavements?

Flexible Pavements are those, which on the whole have low or negligible flexural strength and are rather flexible in their structural action under the loads. The Flexible Pavements layers reflect the deformation of the lower layers on to the surface of the layer.

4) What are the components in Flexible Pavements?

A typical flexile pavement consists of four components

- i) Soil sub grade
- ii) Sub base course
- iii) Base course
- iv) Surface course

5) Define rigid pavement.

Rigid pavements are those, which possess note worthy flexural strength or flexural rigidity. The stresses are not transferred from grain to the lower layers as in the ease of flexible pavement layers. The rigid pavements are made of Portland cement concrete either plan, reinforced or prestressed concrete.

6) What are the functions are in pavement components?

The functions are:

- 1) Soil subgrade are its evaluation
 - a. California bearing ratio test
 - b. California resistance value test
 - c. Triaxial compression test
 - d. Plate bearing test.
- 2) Sub base and base courses and their evaluation
- 3) Wearing course and its evaluation

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7) Define the two parts of pavement design?

Pavement design consists of two parts:

- i) Mix design of materials to be used in each pavement component layer
- ii) Thickness design of the pavement and the component layer.

8) What are the factors considered in design of pavements?

The various factors to be considered for the design of pavements are given below.

- i) Design wheel load
- ii) Sub grade soil
- iii) Climatic factors
- iv) Pavement component materials
- v) Environmental factors
- vi) Special factors in the design of different types of pavements.

9) Give the equation for Boussineq's theory?

The equation for vertical stress computations under a uniformly distributed circular load based on Boussineq's theory is given by:

$$\sigma_z = \frac{P}{\pi} \frac{3Z + 2a}{(a^2 + Z^2)^{3/2}}$$

Here,

σ_z = Vertical stress at depth Z

P=Surface pressure

Z= depth at which σ_z is computed

a= Radius of loaded area.

10) Define the three types of pressure?

The types of pressure are:

- A) Tyre pressure
- B) Inflation pressure
- C) Contact pressure

11) How to measure the contact pressure?

Contact pressure can be measured by relationship:

Load on wheel

Contact pressure = Contact area (or) area of imprint

12) Calculate ESWL of a dual wheel assembly carrying 2004 kg each for pavement thickness of 15,20 and 25 cm. Centre to center tyre spacing 27cm and distance between the walls of the tyres=11 cm.

Solution:

Here=2044 kg 2P= 4088kg D= 11cm S=27cm

X and Y points are plotted on a log graph between ESWL and pavement thickness

X has coordinates (P, d/2) = (2044, 5.5)

Y has coordinates (2P, 2S) = (4088, 54)

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16 Marks questions and Answers

1. Briefly explain the comparison of rigid and flexible pavements?
2. Briefly explain about types of pavement structure?
3. Describe the various functions of pavement components?
4. Explain the various factors to be considered in pavement design? Discuss the significance in each.
5. Write short notes on
 - i)Characteristic of pavement materials
 - ii) Climatic variation
6. Enumerate the various methods of flexible pavement design? Briefly indicate the basis of design in any three cases.
7. Briefly explain the type of stresses?
8. Calculate the stresses at interior, edge and corner regions of a cement concrete pavement using Westergaards stress equations.

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UNIT -4

1. Define – Softening Point of Bitumen

The softening point is the temperature at which the substance attains a particular degree of softening under specified condition of test. The softening point of bitumen is usually determined by ring and ball apparatus.

2. State the desirable properties of road aggregate

The desirable properties of road aggregate are,

- a) Resistance to impact or toughness
- b) Resistance to abrasion or hardness
- c) Resistance from getting polished
- d) Resistance to crushing strength
- e) Good shape factor
- f) Resistance to weathering

3. Define – Flaky Aggregates

Flaky aggregate are those which passes through the designated slots of the thickness gauge which has elongated slots with least dimension equal to 0.6 times of the mean dimension of each size range.

4. Differentiate cut-back bitumen from bitumen emulsions.

Cut back bitumen may not need slightly heating depending on the selected grade of bitumen and the site temperature during mixing. When bitumen emulsion is used in pavement construction no heating is required. Bituminous emulsions are also available with modifiers.

5. Differentiate tar from bitumen.

Bitumen is a petroleum product obtained by the distillation of petroleum crude. Coal tar is produced from coal as a product of coke.

6. What is elongation index?

The elongation index of the aggregate is the percentage by weight of particles, the greatest dimensions of which or its length is greater than one and four fifth or 1.8 times their mean dimensions.

7. Write a few desirable properties of highway materials

A few desirable properties of highway materials are,

- a) Stability
- b) Impact
- c) Incompressibility
- d) Toughness

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8. What are the desirable properties of Soil?

The desirable properties of soil are,

- a) Permanency of strength
- b) Minimum changes in volume and stability under adverse conditions of weather and groundwater
- c) Good drainage
- d) Ease of compaction

9. What are the causes of increase in moisture in a road?

The causes of increase in moisture in a road are,

- a) Percolation of surface water through Earth in the pavement surface.
- b) Entry of water through edge of the pavement
- c) Seepage
- d) Capillary rise from high water table

10. What are the factors to be considered for deformation under a given load?

The factors to be considered for deformation under a given load are,

- a) Sub grade soil type
- b) Soil moisture content and its compaction
- c) Thickness of pavement layers
- d) Drainage conditions.

PART-B

1. Explain the California Bearing Ratio Test
2. What are Tests on bitumen? Explain with neat sketches
3. What are Tests on aggregates? Explain with neat sketches.
4. Explain the construction procedure of bituminous concrete pavement.
5. Explain the construction procedure of cement concrete pavement.
6. Explain the construction of WBM?
7. List few modern materials used in pavement construction with its impact on pavements.

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UNIT-5

1. What are the two types of deterioration takes place in highway pavements?

The two types of deterioration takes place in highway pavements are,

- a) Functional deterioration
- b) Structural deterioration

2. What is unevenness index?

The cumulative value of pavement surface undulations per unit length of road along the longitudinal profile is expressed in terms of unevenness index.

3. What is meant by mud pumping?

Mud pumping is the process of mud or soil slurry being ejected out through the joints and the edges of cement concrete pavement during the movement of heavy vehicles.

4. What are called pot holes?

Pot holes are small bowl shaped holes developed on the surface layer of flexible pavement, generally after rain. The formation of pot holes is the most common types of distress or defect that develops in flexible pavements with bituminous surfacing, at several isolated location.

5. List out the types of cracks formed in the cement concrete roads.

The types of cracks formed in the cement concrete roads are,

- a) Structural cracks
- b) Reflection cracks

6. What are the basic objectives of highway maintenance?

The basic objectives of highway maintenance are,

- a) Continue to provide safe and convenient travel facilities to the road users
- b) Avoid detour, speed changes etc. due to failures in roadway facilities and to minimize the increase in road transportation cost

7. What are the general causes of deterioration to road component?

The general causes of deterioration of road components are,

- a) Rain
- b) Other climatic factors
- c) Changes in ground water condition
- d) Traffic loading
- e) Leakage of water from water supply pipes or sewerage system

8. What is pavement evaluation?

Pavement evaluation is the assessment of the road condition done by panel of road users by present serviceability rating or present serviceability index.

9. What are the classifications of maintenance?

The classifications of maintenance are,

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- a) Routine maintenance (or) repairs
- b) Periodic maintenance
- c) Special repairs.

10. What are two methods of pavements evaluation?

The two methods of pavements evaluation are,

- a) Structural evaluation of pavement
- b) Evaluation of pavement surface conditions.

11. What are Cracks?

Cracks are fissures resulting from partial or complete fractures of the pavements surface. Cracking of road pavement surfaces can happen in a wide variety of patterns, ranging from isolated single crack to an interconnected pattern extending over the entire pavement surface.

12. What are the detrimental effects associated with the presence of cracks?

The detrimental effects associated with the presence of cracks are,

- a) loss of water-proofing of the pavement layers
- b) loss of load spreading ability of the cracked material
- c) pumping and loss of fines from the base course

PART-B

1. Explain the distress in rigid pavements
2. Explain deformation in detail.
3. Explain different cracks in flexible pavements.
4. Explain the Surface defects in detail.
5. Explain disintegration of flexible pavement with neat sketch.
6. Explain pavement evaluation for flexible pavements.
7. Explain pavement evaluation for rigid pavements.