CE6504 HIGHWAY ENGINEERING

UNIT I

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 1in 36 was adopted from the subgrade.

3. Write any two differences between Telford's and Macadam method of road construction.

Factor	Telford's Method	Macadam's method
Subgrade slope	Horizontal	1 in 36
Foundation stones	Stones of large size varying from 220mm at centre to 170mm at edge	Broken stones of uniform 50mm size for bottom layer of 100mm thickness
Base course	Two layers of broken stones compacted to depth of 150mm	One layer of broken stones compacted to depth of 100mm

4. 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

5. 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.

- Some important recommendations are regarding strengthening of existing NH'S, development plans, maintenance of NH, funds required for development etc.,

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
- 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.

11. How length of National Highways has to be computed as per 3rd road development plan?

- As per 3rd road development plan, the National Highways are designed based on the concept of 1km length per 50 sq.km area.
- Hence the total length of NH in an area can be calculated by dividing the total area by 50.

UNIT II

1. What do you understand by non-passing sight distance?

- **Stopping sight distance** is also called non-passing sight distance.

- SSD is the minimum sight distance available on a highway at any spot having sufficient length to enable the driver to stop a vehicle travelling at design speed, safely without collision in event of any obstruction.

2. Define passing sight distance.

- **Overtaking sight distance** is also called passing sight distance.
- Overtaking Sight Distance is the minimum distance open to the vision of the driver of a vehicle intending to overtake the slow moving vehicle ahead safely against the traffic in opposite direction.

3. What are the requirements of ideal transition curve?

- It should meet the straight path tangentially.
- It should meet the circular curve tangentially.
- It should have the same radius as that of circular curve at junction of circular and transition curve.
- The rate of increase of curvature and super elevation should be the same.

4. Define highway capacity.

Highway capacity is defined as the maximum number of vehicles that can pass over a given section of road during a given time period under prevailing roadway and traffic condition.

5. What is PCU?

- PCU is passenger Car Unit
- For traffic analysis, all vehicles are converted to car by multiplying with their PCU value.
  Eg: PCU for Bus – 3, Two wheeler – 0.75.

6. Define traffic density.

Traffic density is defined as the number of vehicles occupying a unit length of roadway at a given instant and is expressed in vehicles per kilometre.

UNIT III

1. Define pavement.

- Highway pavement is a structure consisting of superimposed layers of processed materials above the natural soil sub-grade, whose primary function is to distribute the applied vehicle loads to the sub-grade.
- The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favourable light reflecting characteristics, and low noise pollution.

2. What is rigidity factor in design for highway pavement?

The ratio of contact pressure to the tyre pressure is called Rigidity Factor.

3. Define 'ESWL' (Equivalent Single Wheel Load).

Equivalent Single Wheel Load (ESWL) is the single wheel load having same contact pressure which produces the same value of maximum stress, deflection, tensile stress or contact pressure at desired depth.

4. What is radius of resisting section?

- The maximum bending moment occurs at the loaded area and acts radially in all directions.
- This bending moment can be effectively resisted by a sectional area of the pavement.
- The equivalent radius of resisting section is expressed in terms of radius of load distribution and slab thickness.

5. What is Equivalent Single Axle Load?

- Equivalent Single Axle Load is the equivalent repetitions of standard axle during the design life of the pavement.
- The numbers of repetitions of different types of axles are converted into equivalent repetitions of standard axle by using Equivalent Axle Load Factors (EALF).

6. How do you calculate the ESWL at a given depth below the pavement for a dual wheel assembly?

- ESWL for any depth can be calculated using the following formula.

$$\log_{10} ESWL = \log_{10} P + \frac{0.301 \log_{10}\left(\frac{z}{d/2}\right)}{\log_{10}\left(\frac{2S}{d/2}\right)}$$

- At any depth greater than 2S, the stress due to dual wheel is considered to be equivalent to a single load of magnitude 2P.

7. Define rigid pavement.

Rigid Pavement is defined as the highway pavements with high flexural strength, against the action of loads. These are made of cement concrete and pre-stressed concrete slabs.

UNIT-IV

1. What are the important functions of pavement?

- To distribute the traffic load over the sub-grade soil.
- To provide good riding surface.
- To protect the sub-grade from climatic effects.

2. Write the importance of California Bearing Ratio test.

- It is the best suitable method for evaluating the stability of soil subgrade and other flexible pavement materials.
- The test results have been correlated, for highways and airfields.

3. What are the limitations of C.B.R test?

- It cannot be used to evaluate the soil properties like cohesion or angle of internal friction or shearing resistance.
- Materials passing through 20mm sieve can only be used for this test.
- If the test sample consists of coarse grained particles, then obtained results are not so suitable for proper designing of pavements.

4. Define 'Flakiness Index'.

Flakiness index is defined as the percentage by weight of particles whose least dimension/thickness is less than $3/5^{th}$ or 0.6 of their mean dimension. It can be measured by using thickness gauge.

5. Define 'Elongation Index'.

Elongation index is defined as the percentage by weight of particles whose greatest dimension or length is greater than $1\,4/5^{th}$ or 1.8 times their mean dimension. It can be calculated by using length gauge.

6. Define flaky aggregates.

Angular aggregates and their thickness are small, when compared to their width or length is called Flaky aggregates.

Eg: Laminate rocks.

7. Define angularity number.

It is the amount to the nearest whole number by which the percentage voids exceeds 33%, when an aggregate is compacted in a specified manner in a standardized metal cylinder.

Angularity number = 67-percent solid volume.

8. Name the different types of viscometer with their temperature range

a) Capillary tube viscometer (31ºC to 160ºC)

b) Brooke filed syndro-electric viscometer (38ºC to 160ºC)

c) Sliding plate micrometer (25ºC to 38ºC)

9. Define softening point of bitumen.

Softening point of bitumen is defined as the temperature at which it gradually changes from semi-solid state to liquid state on the application of heat. The test is carried out by using Ring and Ball Apparatus.

10. Differentiate between prime coat and tack coat in bituminous construction.

Prime Coat	Tack Coat
Applied to create bonding between base layer and bitumen layer	Applied to create bonding between bitumen layers.
Application of low viscosity cut backs as primer on existing base layer	Application of low viscosity liquid bitumen to an existing bituminous layer
Sprayed at an uniform rate of 7.3kg to 14.6 kg per 10 sq.m	Sprayed at an uniform rate of 5kg to 10kg per sq.m
Rate of spraying depends on porosity of the surface	Rate of spraying depends on the type of the surface

11. What is the purpose of applying prime coat?

- To plug the capillary voids and to act as a water proofing agent for existing base.
- To provide best bonding between existing granular layer and new bitumen layer.

12. Why joints are provided in rigid pavements?

- To absorb the expansion and contraction due to change of temperature.
- To avoid warping of concrete slab at edges.
- To provide continuity for concrete laying.

13. What are the requirements of ideal joints?

- Should be easy to maintain
- Moves freely without stress development
- Should not allow infiltration of water
- Should be convenient to road users.
- Should be in level with the surface

14. State any two techniques for protecting the subgrade from moisture due to capillary rise.

- Inserting an impermeable or a bituminous layer
- Provide a layer of granular material of suitable thickness

15. Differentiate between tar and bitumen

Factors	Tar	Bitumen
Source	Obtained from destructive distillation of coal or wood	Derived from naturally occurring petroleum
Solubility	Soluble in carbon-disulphide and carbon tetrachloride	Soluble only in toluene
Colour	Black	Black or brownish black

UNIT V

1. What are the reasons for the pavement defects?

- Increase in traffic
- Environmental changes
- Design and construction deficiencies
- Maintenance deficiencies

2. What are the reasons for development of edge cracks in flexible pavements?

- Poor drainage
- Inadequate lateral support
- In-sufficient pavement width

3. Define plastic deformation

    If applied stress is excessive than the stability of sub grade and if the plastic flow takes place, then it is called plastic deformation.

4. Define Warping

    Warping is the bending of the concrete slab due to uneven expansion or contraction of top and bottom slab surfaces. It is caused by any differences in temperature above and below the slab or caused by moisture differences.

5. What are the reasons for disintegration of flexible pavement?

- Improper mix design
- Heavy rainfall or moisture content
- Poor construction and poor materials
- Poor compaction
- Insufficient binder

6. What is unevenness index?

Unevenness index is defined as the cumulative measure of vertical undulations of the pavement surface, recorded per unit length of the road. It can be measured by using Bump Integerator

7. What is mud pumping?

- Mud pumping is the rigid pavement failure
- It happens when water is infiltrated through the cracks, joints and edges of the rigid pavement.
- The water will form soil slurry and it gets ejected when heavy load passes through the cracks or joints.

8. What is spalling in rigid pavement?

Spalling is the breakdown or disintegration of slab edges at joints or at cracks or directly over the reinforcing steel and generally due to the breakdown of pavement joint edges from traffic action.

9. What are the causes of scaling?

- Over vibration of concrete
- Presence of chemical impurities

10. What is mud-jacking?

Mud-jacking is the repairing method of c.c or rigid pavements, in which the raising of settled cement concrete slab or filling a void beneath the slab is done with cement grout.

11. State the remedial measures in rigid pavement for edge cracks.

- Application of sealants
- Application of epoxy resin
- Proper designing method

12. What are the general problems in earthern roads?

- Formation of ruts in longitudinal direction along the wheel path of slow moving vehicles.
- Formation of dust in dry weather.

13. Mention the types of skidding.

- Straight skidding
- Impending skidding
- Sideway skidding

14. Define pavement roughness index.

Pavement roughness index is defined as the grading of irregularities in the pavement surface, that adversely affect the riding quality of a vehicle. It is used to prepare the guidelines for measuring roughness on a standard scale.

15. What is pavement serviceability?

It is defined as the evaluation of pavement in terms of surface unevenness, patching and cracking etc., It is used to analyze the riding quality of pavement.