

**UNIT I – HIGHWAY PLANNING AND****ALIGNMENT PART - A (2 mark)****1. State any contributions made by Jayakar committee for the road development in India.****(APRIL/MAY 10)**

The two major contributions made by Jayakar committee are:

i) Classification of roads in India into five categories.

- National highways
- State highways
- Major district roads
- Other district roads
- Village roads

ii) Creation of central road fund

**2. Define ruling gradient and exceptional gradient.****(APRIL/MAY 10) Ruling****gradient**

This is the desirable upper limit of gradient adopted in the normal course of design. This adoption of ruling gradient should balance the cutting and filling of earth work which will give an economical design. Different factors which are to be considered in the choice of ruling gradient is type of terrain, the length of the grade, the speed. Pulling capacity of vehicles and the presence of horizontal stretches of road.

**Exceptional gradient**

In some ground conditions it will be inevitable to provide a gradient steeper than limiting gradient such gradients are referred to as exceptional gradient.

**3. What are the important modifications made in macadam's method of road construction?****(APRIL/MAY 11)**

Following are the important modifications made in macadam's method:

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

**4. Mention the functions of medians in urban roads.****(APRIL/MAY 11)**

Separators or medians are provided 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 pavements making is the cheapest.

**5. What are the objectives of highway research board?****(MAY/JUNE 12)** Highway

research board of Indian roads congress was set up in 1973. the constitution of the board primarily aims to serve as national centre for road research with the following role to play.

- To ascertain the nature and extent of research required.
- To correlative research information from various organizations in India and abroad with a view to exchanging publications and information on roads.
- To sponsor basic research through universities and research organizations. To
- collect and disseminate of research.
- To coordinate and conduct correlation services.
- To involve in any other matter related to road research.

**6. State the classification of roads according to Nagpur road plan.****(MAY/JUNE 12)** National

- highway
- State highway
- Major district roads
- Other district roads
- Village roads

**7. What is ideal alignment?****(MAY/JUNE 13)**

The alignment should as short and direct possible between the terminal points. This arrangement will be economical in construction, maintenance and operation. The alignment should not interfere to the maximum extent, with agriculture and industries. Further there should be no interference with the utility services like overhead transmission lines, water supply lines, etc.

**8. Define camber.****(MAY/JUNE 13) (NOV/DEC 13)**

Camber, also called as cross fall, is the convexity provided to the cross section of the surface of carriage way. It is the difference in level between the highest point, known as the crown usually located at the centre of the carriage, and the edge.

Camber is provided so as

- To drain surface water
- To separate the traffic in two opposite directions
- To improve the appearance of the road

**9. What is carriage way.****(NOV/DEC 13)**

The pavement width or carriage width depends on the width of traffic lane and number of lanes. The carriage way accommodating one line of traffic movement is called as a traffic lane. The width of the lane is decided based on the width of vehicle and the minimum side clearance may allow more vehicles with high speed.

**10. Give some reasons for the poor state of road development in India?**

The poor state of road development in India in the past may be due to the following reasons: i)

There was no planned development of roads in the country up to the initiation of Nagpur Road plan in the year 1943. Only during the five-year plans since 1951; the development works were speeded up.

- ii) The investment even today on the road development programme is much lower than the revenue from the road transport.
- iii) Poor economic conditions of the vast majority of the population in villages prohibit the owning of private vehicles and discourage the use of transport.

**11. What are the main features in roman roads?**

The main features of the roman roads are: They were built straight regardless of gradients.

They were built after the soft soil was removed and a hard stratum was reached the total thickness of the construction was as high as 0.75 to 1.2 meters at some places, even though the magnitude of wheel loads of animal drawn vehicles was very low.

**12. What are the advantages of road transportation?**

The advantages of transportation are:

- Transportation is for advancement community
- Transportation is essential for the economic and general development of the country.

**13. Give the various characteristics of roadways.**

- Roads are used by various types of road vehicles like passengers, cars, buses; trucks, two or three-wheeled automobiles.etc. But railway tracks are used only by rail locomotives. Waterways are used by only ships.
- Construction & maintenance of roads is cheaper than others.
- Flexibility
- For short distance travel road transport saves time.
- Road transport is the only means of transport that offers itself to the whole community alive.
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**14. What is mean by tresaguet construction?**

Pierre Tresaguet (1716-1796) developed an improved method of construction in France by the year 1764. Tresaguet developed several methods of construction which were considered to be quite meritorious. The main feature of his proposal was that the thickness of construction need be only in the order of 30 cm.

**15. What are the steps allowed in Macadam construction?**

The construction steps are:

- Sub grade is compacted and prepared with a cross slope of 1 in 36 up to a desired width.
- Broken stones of a strong variety, all passing through 5 cm size sieve were compacted to a uniform thickness of 10 cm.
- The second layer of strong broken stones of size 3.75cm was compacted to thickness of 10 cm.
- The top layer consisted of stones of size less than 2cm compacted to a thickness of about 5 cm and finished so that the cross slopes of pavement surface was also 1 in 36.

**16. What are the two important principles of good road construction given by John Macadam construction?**

The principles of good road construction are:

- It is the native soil that supports the traffic load ultimately, and when the soil is maintained in a dry state it can carry heavy loads without settlement.
- Stones which are broken to small angular pieces and compacted can interlock with each other and form a hard surface.

**17. Comparison between Macadam & Telford construction?**

The two methods have been compared here:

Macadam method	Telford method
i) The subgrade was given a cross slope of 1 in 36 to facilitate subgrade drainage.	The subgrade was kept horizontal and hence subgrade drainage was not proper.
ii) The bottom layer of pavement or the subbase course consisted of broken stones of less than 5 cm.	Heavy foundation stones of varying sizes, about 17 cm towards the edges and 22 cm towards the centre were hand packed and prepared to serve as sub base course.
iii) Base and surface courses consisted of broken stones of smaller sizes to compacted thickness of 10 and 5 cm respectively.	Two layers of broken stones were compacted over the foundation stones before laying the wearing course.
iv) The total thickness of pavement construction was kept uniform from edge to centre to a minimum value of only 25cm.	The total thickness of construction varied from about 35 cm at the edge to about 41 cm at the centre.

**18. Define CRF.**

The Central Road Fund (CRF) was formed on 1<sup>st</sup> march 1929. The consumers of petrol were charged an extra levy of 2.64 paise per litre of petrol to build up this road development fund 20 percent of the annual revenue. The accounts of the central road fund are maintained by the Accountant General Revenue. The CRF has been revised in order to augment the revenue under this fund.

**19. What are the various committees and sub committees in IRC?**

IRC has many committees and sub committees:

**Committee:**

- Bituminous committee
- Cement concrete committee
- Road Transport Development committee
- Research organization committee Transport
- operation cost committee Specification
- standard committee

**Sub Committee:**

- Cement road concrete surfacing
- Education of road engineers
- Soil research
- Traffic engineering

**20. Define the objectives of Twenty year Road development plan.**

The broad objectives are:

- i) Provision of good communication in the rural areas is essential to check increasing urbanization.
- ii) The future road system should besides serving the highly developed and agricultural areas, also take into account the needs of the semi-developed and undeveloped areas.
- iii) The road length should be increased as to give a road density of 32 km per 100 sq.km

**21. How do you calculate the total length of metalled road & NH & SH & MDR?**

The formulas are:

$$NH + SH + MDR \text{ (km)} = \left[ \frac{4}{3} \left( \frac{B}{32} \right) + 0.6N + T \right] + D - R$$

Where,

- A = Agricultural area, km<sup>2</sup>
- B = Non-Agricultural area
- N = Number of towns and villages with population range 2001 -5000
- T = Number of towns and villages with population over 5000
- D = Development allowance of 15 percent of road length. R = Existing length of railway track, km

**22. What are the recommendations made by the jayakar committee?**

The most important recommendations made by the committee are:

- i) The road development in the country should be considered as a national interest as the capacity of provincial governments and local bodies.

- ii) An extra tax should be levied on petrol from the road users to develop a road development fund called central road fund.

**23. What is meant by Bombay Road Plan?**

The Second Twenty Year road development plan for the period 1961-81 was initiated by the IRC and was finalized in 1959 at the meeting of the chief engineers and the same was forwarded to the central government. This road development plan is also known as Bombay road plan.

**24. Define IRC.**

Instance of Central government a semi official technical body known as Indian Roads Congress (IRC). The IRC was constituted to provide a forum for regular pooling of experience and ideas on all matters affecting the planning construction and maintenance of roads in India.

**25. What are the objectives of Highway Research Board?**

The objectives of IRC highway research Board are:

- i) To ascertain the nature and extent of research required.
- ii) To correlate research information from various organizations in India and abroad.
- iii) To co-ordinate and conduct correlation services.
- iv) To collect and disseminate results on research.
- v) To channelize consultative services.

**26. Define the main objectives of CRRI.**

The main objectives are:

- i) To carry out the basic and applied research for investigation, design, construction and maintenance of different types of roads and runways.
- ii) To carry out research on road traffic and transportation, including traffic safety and transport economics.
- iii) To render technical advice and consultancy services to various organizations.
- iv) To arrange for utilization of results of research by extension unit, display centers etc.
- v) To conduct refresher and training courses for staff of other research Institutions, Universities and highway Departments.

**27. Define alignment and types of alignment.**

The position (or) the layout of the centerline of the highway on the ground is called the alignment.

**Types:**

- 1) Horizontal alignment
- 2) Vertical alignment

**28. What are the requirements of ideal alignment?**

The basic requirements of ideal alignment between two terminal stations are that it should

- a) Short b) Easy c) Safe
- d) Economical

**29. What are the factors controlling highway alignment?**

The various factors, which control the highway alignment, may be listed as:

- a) Obligatory points
- b) Traffic
- c) Geometric design
- d) Economics
- e) Other considerations

In hill roads additional care has to be given for a)

- Stability
- b) Drainage
- c) Geometric Standards d)
- Resisting Length

**30. What are the stages in engineering surveys?**

The stages of engineering surveys are: Map

- study
- Reconnaissance
- Preliminary surveys
- Final location and detailed surveys

**31. What are the classifications of urban roads?**

The road system within urban areas is classified as urban roads. The urban roads, other than express ways are classified as:

- Arterial roads
- Sub-arterial roads
- Collector roads
- Local roads

**32. Define land width.**

Right of Way is the area of land acquired for the road, along its alignment. The width of this required land is known as land width.

**33. What is mean by Traffic lane?**

The pavement or carriageway width depends on the width of traffic lane and number of lanes. The carriage way intended for one line of traffic movement may be called a traffic lane.

**34. What are the urban applications of remote sensing & GIS? The urban application of remote Sensing and GIS are:**

- In creating construction material Inventions
- Engineering soil mapping
- Slope stability studies
- Highway planning and highway engineering
- Power line location
- Pipe line location
- Site surveys for town planning

**35. Give the various steps in new project work.**

The Various steps are: Map

- study Reconnaissance survey
- Preliminary survey Location
- of final alignment Detailed
- survey
- Materials survey
- Design
- Earth work
- Pavement construction
- Construction controls
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**PART B (16 MARKS)****1. Briefly explain the role of MORTH and IRC in highway development?****(APRIL/MAY 10)(NOV/DEC 13)****Ministry of road transport and highways (MORTH)**

Ministry of road transport and highways is an apex organization under the central government of India. it is entrusted with the power of formulation and administration of road transport in India in construction with other central ministries/departments, state governments/UT administrations, organizations and individuals. Its policies include organization of road transport and national highways and transport research with a view to increase the mobility and efficiency of the road transport system in the country. The ministry has two wings, viz  
.,roads and transport wing.

**Road wing**

Road wing deals with the development and maintenance of national highway in the country. The main responsibilities are:

- Planning, development and maintenance of national highway in India.
- Extending technical and financial support to state governments for the development of state roads of interstate connectivity and economic importance.
- Evolving standard specifications for roads and bridges in the country.
- Serving as a repository of technical knowledge on roads and bridges.

**Transport wing**

Transport wing deals with matters connected to road transport. The main responsibilities are: Motor

- vehicle legislation.
- Administration of the motor vehicle act, 1988
- Taxation of motor vehicles.
- Implementation of compulsory insurance of motor vehicles.
- Administration of the road transport corporations, act, 1950. Promotion of transport co-operatives in the field of motor transport.
- Formation of road safety standards in the form of a national policy on road safety.
- Preparation and implementation of annual road safety plan.
- Collection and compilation and analysis of road accident statistics and take adequate steps for the development of road safety culture in the country.
- Sanction of grants-in-aid to non-governmental organization in accordance with the laid down guidelines.

**New plans and schemes**

Recently the ministry has formed new plans and schemes.

- New national permit system.
- Inviting suggestions for automotive industry standards.
- Scheme for strengthening public transport system. Original
- book writing scheme
- Carriage by road rules 2010.
- Physical and financial targets for 2010-11.
- Guidelines for introduction of expressways.

**Indian road congress (IRC)**

Indian road congress is the premier technical body of highway engineers in the country. On the recommendations of jayakar committee, Indian road congress was set up in December 1934.as the activities of the IRC expanded; it was formally registered as a society's registration act of 1860.

**Role of IRC**

The following are the major roles of the congress.

- To promote and encourage the science and practice of construction and maintenance of roads.
- To suggest improved methods of administration, planning, design, construction, operation, use and maintenance of roads.
- To promote the use of standard specifications and to propose specifications.
- To advice regarding education, experience and research connected with roads.
- To establish, furnish and maintain libraries and museums for furthering the science of road making.

**2. State the factor influencing the highway alignment.**

The various factors which control the highway alignment in general may be listed as:

- Obligatory points Traffic
- Geometric design
- Economics
- Other considerations

**Obligatory points**

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

- Point through which the alignment is to pass.
- Points through which the alignment should not pass.

**Traffic**

The alignment should suit traffic requirements .origin and destination study should be carried out in the area and the desire lane be drawn shown in the trend of traffic flow. The new road to be aligned should keep in view the desired lines, traffic flow patterns and future trends.

**Geometric design**

Geometric design factors such as gradient, radius of curve and sight distance also would govern the final alignment of the highway. If straight alignment is aimed at, often it may be necessary to provide very steep gradients. As far as possible while aligning a new road, the gradient should be flat and less than the ruling or design gradient.

Thus it may be necessary to change the alignment in view of the design speed, maximum allowable super elevation and coefficient of lateral friction. It may be necessary to make adjustment in the horizontal alignment of roads keeping in view the minimum radius of curve and the transition curves.

**Economics**

The alignment finalized based on the above factors should also be economical. In working out the economics, the initial cost the cost of maintenance and vehicle operation should be taken into account. The initial cost of construction can be decreased if high embankments and deep cuttings are avoided and alignment is chosen in a manner to balance the cutting and filling.

**Other consideration**

Various other factors which may govern the alignment are drainage considerations, hydrological factors, political considerations and monotony. The vertical alignment is often guided by drainage considerations. The subsurface water level, seepage flow and high flood level are the factors to be kept in view.

**3. Explain the activities of national highway authority of India. (APRIL/MAY 11)**

National highway authority of India was constituted in 1988 by an act of parliament. The responsibility of the authority is for development, maintenance and management of national highways and for matters connected to or incidental there to. The authority was operationalised in February 1995.

**Role of NHAI**

National highways in India have a total length of about 70500km running in every direction of the country to serve as an arterial network of the country. The national highways authority of India rest as with government of India through the national highway authority of India. it is empowered to implement the national highway development project.

**4. Explain the procedure for carrying out road alignment using remote sensing and GIS technique. (APRIL/MAY 11)**

Photogrammetry or remote sensing is based on aerial photographs which are a basic working tool for the highway engineer.

Vertical ariel photographs taken with the camera pointed nearly straight down are the most useful for highway aligning or mapping purposes. The area to be covered in photographed in parallel runs with the individual pictures lapped both in the direction of flight and between successive runs. For stereoscopic uses, end lap must be greater than half the picture width in order that the centre of photograph is included in both adjacent photographs.

Several instruments are available for converting data from aerial photographs to maps. It is possible to produce accurate map showing all natural and artificial features. Also contours may be drawn which may be used for aligning.

**5. Describe the classifications of urban roads in India. Give the cross section of urban road with all its features.**

(APRIL/MAY 11)(MAY/JUNE 13) The classification of

urban roads in India:

- National highways
- State highways
- Major district roads
- Other district roads
- Village roads

**National highways**

National highways are the main highways running through the length and breath of India, connecting major parts, forgin highways, capital of large states and industrial and tourist centres including roads required for strategic movements for the defense of India.

It was agreed that a first step national trails should be constructed by the centre and that latter's these should be converted into roads to suit the traffic conditions. It was specified that national highways should be the frame on which the entire road communication should be based on that these highways may not necessarily be of same specification, but they must give an uninterrupted road communication through India and should connect the entire road network. **State highways**

State highways are the arterial roads of a state, connecting up with the national highways of adjacent state, district headquarters and important cities within the state and serving as the main arteries for traffic to and from district roads.

These highways are considered as main arteries of commerce by roads within a state or a similar geographical unit. In some places they may be even carry heavier traffic than some of the national highways but this will not alter their designation or function. The NH and SH have some design speed and geometric design specification.

**Major district roads**

Major district roads are the important roads within a district serving areas of production and markets and providing them with outlet to markets and connecting those with each other or with

the main highways of a district. the MDR has lower speed and geometric design specifications than NH/SH.

### Other district roads

Other district roads are roads serving rural areas of production and providing them with outlet to market Centre's taluk headquarters block development headquarters or other main roads. These are of lower design specifications than MDR.

### Village roads

Village roads are road connecting villages or groups of villages with each other to the nearest road of a higher category.

It was specified that these villages roads should be in essence farm tracks, but it was desired that the prevalent practice of leaving such tracks to develop and maintain by themselves should be replaced by a plan for a designed and regulated system.

## 6. Explain the detail about second twenty year road plan.

(MAY/JUNE 12)

### Second Twenty-Year Road Plan (1961-81): -

The nagpur road plan was intended for the period 1943-63, but the target road length was nearly completed earlier in 1961. Hence the next long term plan for the twenty year period commencing from 1961 was initiated by the IRC and was finalized by the subcommittee and this was approved by the Chief Engineers. The Second Twenty Year Road Development plan 1961-81 is also Called Bombay Road Plan.

Five different formulae were framed to calculate the lengths of NH, SH, MDR, ODR, VR. These

five formulae are given below:

a) National highway (km)

$$\left[ \frac{A}{64} + \frac{B}{80} + \frac{C}{96} \right] + [32 k + 8 M] + D \quad (2.3)$$

b) National Highways + State Highways (km) A

$$\left[ \frac{B}{20} + \frac{C}{24} + \frac{C}{32} \right] + [48 k + 24 M + 11.2 N + 1.6 P] + D \quad (2.4)$$

c) National Highways + State Highways + Major district roads (km)

$$\left[ \begin{array}{ccc} \overline{A} & \overline{B} & \overline{C} \\ \hline & & \\ \hline 8 & 16 & 24 \end{array} \right] + [48 k + 24 M + 11.2 N + 9.6 P + 6.4 Q + 2.4 R] + D$$

d) National Highways + State Highways + Major district roads + Other District roads (km)

$$\left[ \begin{array}{ccc} \overline{3A} & \overline{3B} & \overline{C} \\ \hline & & \\ \hline 16 & 32 & 16 \end{array} \right] + [48 k + 24 M + 11.2 N + 9.6 P + 12.8 Q + 4 R + 0.8 S + 0.32 T] \quad (2.6)$$

e) National Highways + State Highways + Major district roads + Other District roads + Village roads

$$\left[ \begin{array}{ccc} \overline{A} & \overline{B} & \overline{C} \\ \hline & & \\ \hline 4 & 8 & 12 \end{array} \right] + [48 k + 24 M + 11.2 N + 9.6 P + 12.8 Q + 5.9 R + 1.6 S + 0.64 T + 0.2 V] + D$$

Where

A = Developed and agricultural areas; km<sup>2</sup>

B = Semi-Developed area, km<sup>2</sup>

C = Undeveloped area, km<sup>2</sup>

K = Number of towns with population over 1,00,000

M = Number of towns with population range 1,00,000-50,000

N = Number of towns with population range 50,000-20,000

P = Number of towns with population range 20,000-10,000

Q = Number of towns with population range 10,000-5,000

R = Number of towns with population range 5,000-2000

S = Number of towns with population range 2,000-1,000

T = Number of towns with population range 1000-500

V = Number of towns with range below 500

D = Development allowance of 5 percent of road length calculated for further development and other unforeseen factors.

**Salient features of the second 20-year plan (1961-81):-**

- This plan is considered to be drawn more scientifically in view of development needed in under-developed areas.
- Maximum distance of any place in a developed or agricultural area would be 6.4 km from a metalled road and 2.4 km from any category of roads.
- The maximum distance from any place in a semi-developed area would be 12.8 km from a metalled road and 4.8 km from any road.
- Every town with population above 2000 in plains and above 1000 in semi-hill areas and above 500 in hilly areas should be connected by a metalled road.
- Expressways have also been considered in this plan and 1600 km of length has been included in the proposed target of national highways.
- Length of railway track is considered independent of the road system and hence it is not subtracted to get the road length.
- The development factor of only 5 percent is provided for future development and unforeseen factors.

**7. Write brief notes on:****(MAY/JUNE 12)****i) Central road fund**

based on the authority of a resolution adopted by the Indian legislature, the central road fund was formed on 1st March 1929. The consumers of petrol were charged an extra levy of 2.64 paise per liter of petrol to build up this road development fund. 20 percent of the annual revenue is to be retained as a central reserve, from which grants are to be given by the central government for meeting expenses on the administration of the road fund, road experiments and research on road and bridge projects of special importance. The balance 80 percent is to be allotted by the central government to the various states based on actual petrol consumption or revenue collected.

**ii) Indian road congress**

At the instance of central government a semi official technical body known as Indian road congress was formed in 1934. This may be recalled is one of the main recommendations made by the Jayakar committee. The Indian road congress was constituted to provide a forum for regular pooling of experience and ideas on all matters affecting the planning, construction and maintenance of roads in India, to recommend standard specification and to provide a platform for the expression of professional opinion on matters relating to road engineering including such questions as those of organization and administration.

**iii) Central road research institute**

In the year 1950 the central road research institute was started at New Delhi for research in various aspects of highway engineering. It may be indicated that one of the recommendations of the Jayakar committee report was to set up a central organization for research and dissemination of information.

The CRRI is one of the national laboratories of the Council of Scientific and Industrial Research. The institute is mainly engaged in applied research and offers technical advice to state governments and the industries on various problems concerning roads.

**iv) National highway authority of India**

National highway authority of India was constituted in 1988 by an act of parliament. The responsibility of the authority is for development, maintenance and management of national highways and for matters connected to or incidental there to. The authority was operationalised in February 1995.

**Role of NHAI**

National highways in India have a total length of about 70500km running in every direction of the country to serve as an arterial network of the country. The national highways authority of India works with government of India through the national highway authority of India. It is empowered to implement the national highway development project.

**8. Explain the requirement of ideal alignment.****(MAY/JUNE 13)**

The basic requirement of an ideal alignment between two terminal stations is that it should be: Short

- Easy Safe
- Economical
- 

**Short**

It is desirable to have a short alignment between two terminal stations. A straight alignment would be the shortest, though there may be several practical considerations which would be the shortest, though there may be several practical considerations which would cause deviations from the shortest path.

**Easy**

The alignment should be such that it is easy to construct and maintain the road with minimum problems. Also the alignment would be easy for the operation of vehicles with easy gradient and curves.

**Safe**

The alignment should be safe enough for construction and maintenance from the view point of stability of natural hill slopes, embankments. Also it should be safe for the traffic operation with safe geometric features.

**Economical**

The road alignment could be considered economical only if the total cost including initial cost, maintenance cost and vehicle operation cost is lowest. All these features should be given due consideration before working out the economics of each alignment.

**9. Briefly explain the Tresaguet and Macadam's method of road construction?****Tresaguet construction:**

Pierre Tresaguet (1716-1796) developed an improved method of construction in France by the year 1764. The main feature of his proposal was that the thickness of construction need be only in the order of 30 cm.



Tresaguet was the inspector General of roads in France from 1775 to 1785. So his method of construction was implemented in that country in 1775.

The typical cross section of Tresaguet's road construction is given in fig. and the construction steps may be enumerated as below.

- i) The sub grade was prepared and layers of large foundation stones were laid on edge by hand. At the two edges of the pavement large stones were embedded edge wise to serve as submerged kerbs stones.
- ii) The corners of the heavy foundation stones were hammered and then the interstices filled with smaller stones.
- iii) The top-wearing course was made of smaller stones and compacted to a thickness of about 5 cm at the edges and gradually increased towards the center.
- iv) The shoulders were also provided cross slope to drain the surface water to the side drain.

### **Macadam Construction**

John Macadam put forward an entirely new method of road construction as compared to all the previous methods. A typical cross section of Macadam construction:

- i) The importance of sub grade drainage and compaction were recognized and the sub grade was compacted and was prepared with a cross slope of 1 in 36.
- ii) Macadam was the first person to suggest the heavy foundation stones are not at all necessary to be placed at the bottom layer of construction.
- iii) Though the total thickness of construction was less than previous methods. This technique could serve the purpose in a better way.
- iv) The size of broken stones for the top layer was decided based on the stability under animal drawn vehicles.

Macadam's method is the first method based on scientific thinking

The construction steps are:

- i) Sub grade is compacted and prepared with a cross slope of 1 in 36 up to a desired width.
- ii) Broken stones of a strong variety, all passing through 5 cm size sieve were compacted to a uniform thickness of 10cm.
- iii) The second layer of strong broken stones of size 3.75 cm was compacted to thickness of 10 cm.
- iv) The top layer consisted of stones of size less than 2 cm compacted to a thickness of about 5 cm. The cross slope of pavement surface was also 1 in 36.

### **10. Briefly explain the engineering surveys needed for locating a new highway?**

The stages of the engineering surveys are:

- a) Map study.
- b) Reconnaissance.
- c) Preliminary surveys.
- d) Final location and detailed surveys.

**Map study: -**

In the topographic map, to suggest the likely routes of roads. In India topographic maps are available from the survey of India with 15 or 30-meter contour intervals.

The main feature like rivers, hills, and valleys etc. The probable alignment can be located on the map from the following details available on the map.

- Alignment avoiding valleys, ponds or lakes
- When the road has to cross a row of hills, possibility crossing through a mountain pass.
- Approximate location of bridge site for crossing rivers, avoiding bend of the river.
- When a road is to be connected between two stations one of the top and the other on the foot of the hill then alternate routes can be suggested keeping in view the permissible alignment.
- Suppose the scale of the contour map is known, and then the contour intervals it is possible to decide the length of road required between two consecutive contours keeping the gradient within allowable limits.
- In the fig. Let A and B be two stations to be connected by road. AB is the shortest route (Straight line) APQB is a steep route in which the gradient positively exceeds 1 in 20 as the distance between the contour intervals is only about 200 meter.
- APLMNB is a route with an approximate slope of 1 in 20 whereas APEFGB is an alternate alignment with the same gradient.
- Thus the map study also is possible to drop a certain route in view of any unavoidable obstructions (or) undesirable ground reroute.

**Reconnaissance:-**

The second stage of surveys for highway location is the reconnaissance to examine the general character of the area for deciding the most feasible routes for detailed studies.

Some of the details to be collected during reconnaissance are given below:

- Valleys, ponds, lakes, marshy, land, ridge, hills, permanent structures and other obstructions along the route, which are not available in the map.
- Approximate values of gradient, length of gradients and radius of curves of alternate alignments.
- Number and types of cross drainage structures maximum flood level and natural groundwater level along the probable routes.
- Soil type along the routes from field identification tests and observation of geological features.
- Sources of construction materials water and location of stone quarries.
- When the road passes through hilly or mountainous terrain, additional data regarding the geological formation types of rocks, dip of strata, seepage flow etc.

**Preliminary survey: -**

The main objectives of the preliminary surveys are:

- To survey the various alternate alignments proposed after the reconnaissance and to collect all the necessary physical information and details of topography, drainage and soil.
- To compare the different proposals in view of the requirements of a good alignment.
- To estimate quantity of earthwork materials and other construction aspects and to work out the cost of alternate proposals.
- To finalize the best alignment from all considerations.

The procedure of the conventional methods of preliminary surveys the given steps:

**Primary survey: -**

For alternate alignments either secondary traverses (or) independent primary traverses may be necessary.

**Topographical features: -**

All geographical and other man made features along the traverse and for a certain width on either side surveyed and plotted.

**Leveling work: -**

Levelling work is also carried out side by side to give the centerline profiles and typical cross sections. The leveling work in the preliminary survey is kept to a minimum just sufficient to obtain the approximate earthwork in the alternate alignments.

**Drainage studies: -**

Drainage investigations and hydrological data are collected so as to estimate the type, number and approximate size of cross and drainage structures.

**Soil survey: -**

The soil survey conducted at this stage helps to working out details of earthwork, slopes, suitability of materials, subsoil and surface drainage requirements and pavement type and the approximate thickness requirements.

**Material survey: -**

The survey for naturally occurring materials like stone aggregates, soft aggregates etc and identification of suitable quarries should be made.

**Traffic survey: -**

Traffic surveys conducted in the region from basis for deciding the number of traffic lanes and roadway width, pavement design and economic analysis of highway project.

**Final location and detailed survey: -**

The alignment finalized at the design office after the preliminary survey is to be first located on the field by establishing the centerline. The detailed survey should be carried out for collecting the information technology for the preparation of plans and construction details.

**Location: -**

- The centerline of the road finalized in the drawings to be translated on the ground during the location survey.
- Major and minor control points are established on the ground and center pegs are driven, checking the geometric design, requirements.

**Detailed survey: -**

Levels along his final centerline should be taken at all staked points.  
Leveling work is to great importance as the vertical alignment.

A detailed soil survey is carried out to enable drawing of the soil profile. The data during the detailed survey should be elaborate and complete for preparing detailed plans, design and estimates of the project.

**11. Write short notes on:**

- i) **Right of way**
- ii) **Carriage way**
- iii) **Camber**
- iv) **Krebs**

**Right of way:**

Right of way is the area of land acquired for the road along its alignment. The width of this acquired land is known as land width and it depends on the importance of the road and possible future development.

A minimum land width has been prescribed for each category of road. The land width is governed by the following factor:

- i) Width of formation depending on the category of highway and width of roadway and road margins.
- ii) Height of embankment or depth of cutting which is governed by the topography and the vertical alignment.
- iii) Side slopes of embankment (or) cutting which depend on the height of the slope. Drainage system and their size. Which depends on the rainfall, topography and runoff.

**Carriage way (or) Width of pavement:**

The pavement or carriageway width depends on the width of traffic lane and number of lanes. The carriage way intended for one line of traffic movement may be called a traffic lane.

Keeping all these in view a width of 3.75m is considered desirable for a road having single lane for vehicles of maximum width 2.44m. For pavements having two or more lanes, width of 3.5m per lane is considered sufficient.

The maximum width of vehicle as per IRC specification is 2.44m. If a single carriageway of width 3.8m is provided, a side clearance of 0.68m would be obtained in fig.

In the case of two lane pavement of width 0.7m a minimum clearance between two lanes of traffic would be 1.06m for the widest vehicles on the road. The number of lanes required in a highway depends on the predicted traffic volume and the design traffic volume of each lane.

**Camber:**

Camber (or) cross slope is the slope provided to the road surface in the transverse direction to drain off the rain water from the road surface. The pavement surface by providing cross slope is considered important because of two reasons.

i) To prevent the entry of surface water into the sub grade soil through pavement. ii) To prevent the entry of water into the bituminous pavement layers, as continued contact with water causes stripping.

iii) To improve the rainwater from the pavement surface as quickly as possible and to allow the pavement to get dry soon after the rain.

The rate of camber or cross slope is usually designated by 1 in n which means that the transverse slope is in ratio 1 vertical to n horizontal. Camber is also expressed as a percentage.

The required camber of a pavement depends on:

i) The type of pavement surface ii)

The amount of rainfall

The minimum camber needed to drain off surface water may be adopted keeping in view the type of pavement surface and the amount of rainfall in the locality.

Too steep cross slope is not desirable because of the following reasons:

i) Transverse skidding of vehicles causes uncomfortable side thrust and a drag on the steering of automobiles.

ii) Discomfort causing throw of vehicle when crossing the crown during overtaking operations.

iii) Problems of toppling over of highly laden bullock carts and trucks. iv)

Formation of cross ruts due to rapid flow of water.

v) Tendency of most of the vehicles to travel along the center line.

**Kerbs:**

Kerbs indicate the boundary between the pavement and shoulder (or) sometimes island or foot path or kerb parking space.

There is variety of kerb designs; kerbs may be mainly divided into three groups based on their functions.

i) Low (or) mountable type kerbs which though encourage traffic to remain in the through traffic lanes, yet allow the driver to enter the shoulder area with little difficulty. This type of kerb is provided at medians and channelization schemes and is also useful for longitudinal drainage system.

ii) Semi-barrier type kerb is provided on the periphery of roadway where the pedestrian traffic is high.

This type of kerb has a height of about 15cm above the pavement edge with a batter of 1:1 on the top 7.5 cm. This kerb prevents encroachment of parking vehicles. But at acute emergency it is possible to drive over this kerb with some difficulty.

- ii) Barrier type kerb is provided in built up areas adjacent to foot paths with considerable pedestrian traffic. The height of kerb stone is about 20 cm above the pavement edge with a steep batter of 1.0 vertical 0.25 horizontal.

## **12. Explain the third twenty year road plan.**

### **Third Twenty-Year Road Development Plan 1981-2001: -**

#### **Policies and objectives:**

The Third Twenty Year Road development Plan 1981-2001 (also Known as Lucknow Road Plan) was finalized and the plan document was published by the year 1984. The major policies and objectives of this road plan are listed below:

- a) The feature road development should be based on the revised classification of road system consisting of primary, secondary and tertiary road systems.
- b) The road network should be developed so as to preserve the rural oriented economy and to develop small towns with all the essential facilities.
- c) The overall road density in the country should be increased to 82 km per 100-sq.km areas by the year 2001.
- d) The national highway network should be expanded to form square grids of 100 km sides so that no part of the country is more than 50 km away from a NH.
- e) The lengths of SH and MDR required in a state or region should be decided based on both areas and number of towns with population above 5,000 in the state or region.
- f) Expressways should be constructed along major traffic corridors to provide fast travel.
- g) Roads should also be built in less industrialized areas to attract the growth of industries.
- h) There should be improvements in environmental quality and road safety









