

UNIT

1

HIGHWAY DEVELOPMENT AND PLANNING

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PART-A

SHORT QUESTIONS WITH SOLUTIONS

Q1. What are the characteristics of a good alignment of a hill road?

Model Paper-I, Q1(a)

Answer :

The characteristics/features of a good alignment of a hill road are summarised as follows,

1. The total distance between two terminals should be as short as possible i.e., length of road should be short.
2. A good alignment should be prevented from steep terrain and other inaccessible areas.
3. Ruling gradient is to be obtained in almost every road.
4. An alignment should provide a good drainage system.
5. Hair pin bends should be avoided, or use of hair pin bends should be minimised.
6. Alignment should be prevented from deep sunlight rather than shady or snow areas.
7. The alignment should be under direct sunlight rather than shady or snow areas.
8. Gradient and curve should not be combined.

Q2. What are the vital requirements of a hill road?

Model Paper-III, Q1(a)

Answer :

The vital requirements of a hilly road should have the following according to practical and local conditions as,

1. Provision of watering and fueling places to the possible extent.
2. Ruling gradient should be maintained, except in some cases.
3. The initial cost of construction and maintenance should be economical.
4. The vertical curves should be parabolic to the maximum extent.
5. Good substrate to be required as a stable foundation and also landslides should be avoided.
6. The minimum requirement of I.R.C should be fulfilled in site distance of all the points.
7. Properly designed curves to be executed and also the curves should be free from blind corners.

Q3. What are the characteristics of a good road?

Model Paper-II, Q1(a)

Answer :

The following are the characteristics of a good road,

1. Road should remain dry.
2. Road should possess better carriage way.
3. Road should possess smooth gradients and large smooth curves.
4. It should possess good wearing surface and impervious surface.
5. The construction and maintenance of road should be easy and cheap respectively.
6. Road should be short and straight.
7. There should not be any slushy and dust particles over the surface of road.
8. Road should be cleaned and repaired without any difficulty.
9. Road should possess good eminities unroute.



Q4. List out advantages of roads.

Answer :

Model Paper-II, Q1(b)

The main advantages of roads are as follows,

1. During war and peace time, a network of roads is a benefit to national level defence.
2. Roads allow easy movement of men and material from one location to another.
3. Superior law and order can be maintained, if the network of roads in the country is good.
4. The maintenance of educational, employment and cultural contacts is done by means of good roads.
5. Roads assist in development of trade and other economic activities inside and outside the village and town.
6. Roads help as suppliers for railways, airways and waterways.
7. The improvement of national resources of an area is done by means of good network of roads.
8. Roads are important for the economic success and general growth of country. The country with good mileage of roads is said to be more progressive and successful.
9. Roads assist for,
 - (a) Good medical provisions for the human.
 - (b) Growth of tourism and superior recreation.
 - (c) Better fire protection and police protection.
 - (d) Improving the facilities of agriculture and marketing.

Q5. What are the different plans to be prepared after the planning surveys are carried out?

Answer :

Model Paper-III, Q1(b)

Generally, all the information is collected during the fact finding surveys before finalising the alignment and other details of the project. This information is presented in the form of plans. There are usually four types of plans as follows,

- (i) Plan I
 - (ii) Plan II
 - (iii) Plan III
 - (iv) Plan IV.
- (i) **Plan I**
Plan I drawing consists of a general area plan showing almost all existing details such as topography, existing road network, rivers, canals or lakes, drainage system, etc., towns and villages with population along with commercial and industrial buildings and agricultural activities.
- (ii) **Plan II**
In plan II, distribution of population groups with respect to the categories made in the appropriate plan is shown.
- (iii) **Plan III**
Plan III represents the locations of various places with their respective quantities of productivity.

(iv) **Plan IV**

Plan IV is an important plan which shows the existing road network with the flow of traffic and the desired lines obtained from origin to destination studies of traffic. This plan may also contain various proposals received from different sources.

Q6. Explain the necessity of highway surveys.

Answer :

Necessity of Highway Surveys

The layout of the centreline of highway roads location on the ground is termed as alignment. The road alignments should be carefully selected, as it will be very difficult to make any changes, once the alignment is done. Hence, various highway surveys are conducted to make the overall cost of the project minimised. The other requirements of highway surveys are,

- (i) Initial cost of constructions
- (ii) Regular costs of maintenance of highways
- (iii) Vehicles operating cost
- (iv) Social and environmental requirements.

Q7. Mention how the recommendation of Jayakar committee report helped in road development in India?

Answer :

The role of the central government in the road development was recognised due to the recommendations of Jayakar committee. It suggested to encourage the motor transport in the country and later imposed additional taxation on the motor transport. These additional funds were transferred to central revenue as road development fund for the purpose of development of roads.

Q8. List the various requirements of Highway Ideal Alignment?

Answer :

(May-17, (R13), Q1(b) | Model Paper-I, Q1(b))

The requirements of good highway alignment are,

1. The length of alignment between two terminal stations should be short.
2. The alignment should be easy in construction and maintaining of roads and also for the vehicle operations.
3. From stability point of view, the alignment should be safe to construct and maintain the natural hill slopes, embankment, cut slopes and foundation of embankments.
4. It should also be safe for the operation of traffic with geometric characteristics.
5. The total cost (i.e., initial cost, maintenance cost and vehicle operation cost) of the road alignment should be low.

Q9. Discuss the objectives of reconnaissance survey and state the instruments used for this purpose.

April-18, (R15), Q1(b)

Answer :

The following are the instruments used for reconnaissance survey.

- (i) Abney level
- (ii) Pedometer
- (iii) Aneroid barometer
- (iv) Clinometers
- (v) Ghat tracer.

Q10. State the classification of roads as per first road development plan.

April-18, (R15), Q1(a)

Answer :

For answer refer Unit-I, Q17, From : Nagpur road plan to VR.

Q11. Classify the road systems at regional/national and urban level.

May-16, (R13), Q1(a)

Answer :

For answer refer Unit-I, Q25, Topic: Urban Roads, Non-urban Roads.

PART-B**ESSAY QUESTIONS WITH SOLUTIONS****1.1 HIGHWAY DEVELOPMENT IN INDIA – NECESSITY FOR HIGHWAY PLANNING**

Q12. Write a note on highway development which took place in India.

Answer :

Model Paper-II, Q3(b)

Highway Development in India

Roads in Ancient India

1. In early 25 to 35 BC the excavation of Mohenjo-daro and Harappa have revealed the existence of roads.
2. These roads were considered as indispensable for administrative and military purpose in old records in early period.
3. In 4th century of Aryan period the ancient script refers to the existence of roads.
4. For regulating the depth of roads for different purposes and different kinds of traffic rules have been mentioned by the first prime minister of emperor Chandra Gupta Maurya in Kautilya.
5. Ashoka had improved the roads and facilities for the travellers in the beginning of 5th century.

Roads in Mughal Period

1. In the time of Mughal period roads were greatly improved and they received great appreciation for the construction of highways.
2. Linking with coastal and central parts roads were built running from N-W to the Eastern areas through the gangetic plains.

Roads in Nineteenth Century

1. Roads were deteriorated during the British rule. In the existing old roads, a number of trunk roads with metalled and bridges were provided under the supervision of British Military Engineers.
2. The public work department was formed by the governor general of Lord Dalhousie in 1865 has undertaken the grand trunk road construction.

Q13. Write explanatory notes on the following,

- (a) Indian road congress
- (b) Jayakar committee and recommendations.

Answer :

(a) Indian Road Congress

From the recommendations of Jayakar committee, a semi-official technical body was formed in 1934, known as "Indian Road Congress" (IRC). The IRC is especially formed for the following,

1. To provide meetings for regular pooling experience, views and ideas on all matters, which affects the planning, construction and maintenance of roads.
2. To recommend for standard specification for roads development.
3. To make a platform for the professional opinions and views on matters related to road engineering.

The IRC plays a significant role in the formulation of three 20 year road development plans. Now-a-days, IRC has made as an active body of national importance, which controls and regulates the specifications, standardization and recommendations on materials, design and construction of roads and bridges. The technical activities of IRC are carried out by highway research board and various committees. The IRC publishes journals, guidelines for standard specification research and special aspects on highway engineering.

(b) Jayakar Committee and Recommendations

After first world war, the existing roads are not capable to withstand the "mixed traffic condition", due to large number of vehicles started plying on roads. Thus, there was a demand for the better road network, which can withstand the "mixed traffic condition".

In 1927, a resolution was passed by both the chambers of Indian legislature to appoint a separate committee for examining and development of roads in India. Therefore, Indian road development committee was appointed by the central government with "Mr. Jayakar" as a chairman.

UNIT-1 Highway Development and Planning

In 1928, the important recommendations were made by "Jayakar committee" after surveying the Indian roads, are as follows,

1.5

1. Road development must be considered as a national interest because, it was uncontrolled and out of range from the capability of provincial government and local bodies.
 2. A "Central Road Fund" must be collected from the road users in terms of extra tax on petrol.
 3. A semi-official technical body should be formed to withstand the technical failures from various sides of country and it must act as an advisory body in various aspects of road development.
 4. An organisation for research should be established to carry out R and D work and easily available for consultation.
- Q14. Explain the necessity for carrying out highway planning.**

OR**Model Paper-I, Q2(a)**

What is the need for highway planning? Discuss the benefits of well-planned highway system in the social and economic development of a country.

Answer :

Every project requires an adequate planning for its safe and economical execution. Hence, highway planning is also an important requirement for the development of highways. In case of developing countries, the planning of highways is of major importance as the available funds for the project are much lower than required. The main aims of highway planning are as follows,

1. For proper planning of road-network such that the various operations and movements over the highways are safe and efficient. The cost of planning should be given a sufficient care considering the costs of construction, maintenance, renewal operations etc. The project should be planned for lowest cost possible.
2. To give priorities to various operations and works involving in the construction depending upon their utility.
3. Planning is also done for future developments and improvements in the existing highways.
4. To plan the type and alignment of road by considering various factors such as its use, funds available, time limit of construction etc.
5. To calculate the costs incurred in the project under consideration.

Q15. Explain the concept of mobility and accessibility.

Answer :**Mobility Enhancing Strategy**

1. This strategy is mainly focused on improving the performance of the system and to improve the flow of traffic.
2. Construction of new roads, expansion of existing roads, road building renovations has paved the prominent enhancing strategy in the developing countries.
3. Another field of mobility enhancing strategy has launched known as ITS (Intelligent Transportation System).
4. There are different applications in ITS and the main aim is to improve efficiency of transport system and to make use of existing capacity.
5. To increase the potential for movement is the primary goal for both road building and ITS.
6. This application includes many categories such as intelligent vehicle, commercial vehicle, transit and traffic management and have a variety of technologies like communications, information processing and control technologies.

Accessibility Enhancing Strategy

1. The strategies which shows direct impact access are various land use strategies and services to provide via telecommunication technology.
2. In order to meet the needs of individuals and to reduce the negative impact of automobile dependence, these approaches has directly ensure better access and at the same time they reduce the need for travel.
3. This approach also improves the considerable attention for both potential transportation benefits and to quality of life.
4. A travel impedance element and a destination attractiveness element is included in accessibility in which the land use strategy plays an important role in enhancing accessibility.

Q16. What are the various recommendations of Jayakar Committee? How were these implemented?

Answer :

For answer refer Unit-I, Q13(b) and Q7.

May-17, (R13), Q3(a)

1.2 DIFFERENT ROAD DEVELOPMENT PLANS

Q17. What is the importance of Nagpur road plan in highway planning of our country? Explain the plan formulae and the salient features of the plan.

Answer :

Nagpur Road Plan

Nagpur road plan is given high importance in highway planning programmes as it was the first road development plan suggested and implemented by Indian Road Congress. It is also known as the "First 20 year road plan" and was planned in the year 1943.

In this plan the roads are divided into five types based on their location and use. The five categories are,

- National Highways (NH)
- State Highways (SH)
- Major District Roads (MDR)
- Other District Roads (ODR) and
- Village Roads (VR).

National highways are the roads which connect the major ports of country, capital of different states, foreign highways etc. The national highways are again sub-divided and are named NH-1, NH-3 etc., based on the states they connected. State highways are the roads which lead to the national highways while the major district roads are the roads used for accessing the various serving areas within a district. The other district roads also give the access to various areas within a district but are provided only for rural areas. Finally, the village roads provide a means of connection between various villages and lead to a road of higher category.

Plan Formulae

Two plan formulae are given by the IRC (named as star and grid formulae) to calculate the length of the highway. They are given as below,

(a) For National Highways + State Highways + Major District Roads

$$\text{Length, } L = \left[\frac{A}{\delta} + \frac{B}{32} + 1.6N + \delta T \right] + D - R$$

Where,

A - Agricultural area in km^2

B - Non-agricultural area in km^2

N - Number of towns and villages with population between 2001-5000

T - Number of towns and villages with population > 5000

D - 15% allowance for future development

R - Length of already existing railway track in km.

(b) For Other District Roads and Village Roads

$$\text{Length, } L = (0.32 V + 0.8 Q + 1.6 P + 3.2 S) + D$$

Where,

V - Number of villages with population not exceeding 500.

Q - Number of villages with population between 501- 1000

P - Number of villages with population between 1001-2000

S - Number of villages with population between 2001-5000

D - Allowance of 15% for future developments.

From the above formulae, it is clear that the length of the highway is calculated considering the different population ranges from towns and villages.

Salient Features of Nagpur Road Plan

The salient features of Nagpur road plan are as follows,

1. Central government is given the responsibility for construction and maintenance of all the national highways.
2. A total length of 5,32,700 km with a density of 16 km/100 km² is proposed.
3. The plan formulae were developed considering the star and grid road-network pattern. Hence specific importance should be given to the existing roads with irregular pattern.
4. Main grids are provided through first category roads, which brings the development and agricultural area at a distance not exceeding 8 km from the metallic roads. The grid size provided is 16 km.
5. For non-agricultural area, the grid size provided is 64 km and the maximum distance between the farthest point to the metallic road is limited to 32 km.
6. Second category roads are also provided as links between small villages. The length of these roads is calculated considering the population in different villages.
7. 15% allowance is given for the roads of both categories for further developments.
8. While calculating the length, the length of railway tracks is also considered in the area. This length is subtracted from the calculated road length.

Q18. Discuss the second twenty year road plan of 1961-81 and its salient features.

Answer :

Second Twenty Year Road Plan

The second twenty year road plan was initiated in 1961 only because of the early completion of Nagpur road plan. The plan was developed by the Indian road congress. The sub-committee finalized the plan and the chief engineers from various parts of country gave approval to the plan. As it was proposed in Bombay, it is also known as the Bombay road plan. The total length to be developed is aimed at 10,57,330 km by the end of the plan. This distance is nearly 50% more than the first twenty year road plan. An estimated cost of nearly 5,200 crores was also worked out for the whole completion period.

Different formulae are given by the committee to calculate the length for different types of roads. The formulae are given as below,

(a) **National Highways**

$$L = \left(\frac{A}{64} + \frac{B}{80} + \frac{C}{96} \right) + (32 \times K + 8 M) + D \quad \dots (1)$$

(b) **National + State Highways**

$$L = \left(\frac{A}{20} + \frac{B}{24} + \frac{C}{32} \right) + (48 K + 24 M + 11.2 N + 1.6 P) + D \quad \dots (2)$$

(c) **National Highways + State Highways + Major District Roads**

$$L = \left(\frac{A}{8} + \frac{B}{16} + \frac{C}{24} \right) + (48 K + 24 M + 11.2 N + 9.6 P + 6.48 Q + 2.4 R) + D \quad \dots (3)$$

(d) **National Highways + State Highways + Major District Roads + Other District Roads**

$$L = \left(\frac{3A}{16} + \frac{3B}{32} + \frac{C}{16} \right) + (48 K + 24 M + 11.2 N + 9.6 P + 12.8 Q + 4 R + 0.8 S + 0.3 T) + D \quad \dots (4)$$

(e) **National Highways + State Highways + Major District Roads + Other District Roads + Village Roads**

$$L = \left(\frac{A}{4} + \frac{B}{8} + \frac{C}{12} \right) + (48 K + 24 M + 11.2 N + 9.6 P + 12.8 Q + 5.9 R + 1.6 S + 0.64 T + 0.2 V) + D \quad \dots (5)$$

1.8

Where,

A – Developed areas or agricultural areas in km^2

B – Partially or semi developed areas in km^2

C – Undeveloped area in km^2

K – Number of towns with population 1,00,000

M – Number of towns with population between 1,00,000 to 50,000

N – Number of towns with population between 50,000 to 20,000

P – Number of towns with population between 20,000 to 10,000

Q – Number of towns with population between 10,000 to 5,000

R – Number of towns with population between 5,000 to 2,000

M – Number of towns with population between 2,000 to 1,000

T – Number of towns with population between 1,000 to 500

V – Number of towns with population < 500

D – 5% increase in proposed length for further development of road in future.

Length ' L ' from all the above formulas is obtained in kilometers (km).

Salient Features of Bombay Road Plan

The salient features of Bombay road plan are as follows,

1. This plan mainly emphasizes in the development of areas which are not fully developed. The aim is to achieve a total road length of 32 km/100 km^2 . This length is nearly double that of the length aimed in the first twenty year road plan.
2. The distance of any particular area is limited to a distance of 6.4 km from metalled road and to a distance of 2.4 km from other roads.
3. The distance of any semi-developed area is limited to a distance of 12.8 km from metalled road and to a distance of 4.8 km from other roads.
4. The distance of any undeveloped area is limited to a distance of 19.2 km from metalled road and to a distance of 8.0 km from other roads.
5. For the calculation of road length in hilly regions, the lengths should be increased to 100% more than the proposed length.
6. Metalled road should be connected to the town according with the following requirements,

Area	Population
Plain	2000
Semi-hilly	1000
Hilly	500

7. The railway track length is calculated separately and is independent of length of road system.
8. A length of 1600 km is proposed for the provision of expressways in national highways.
9. Only 5% allowance is made in the length for the future development purposes.

Q19. Enumerate the different road development plans in India. Explain the "Third twenty year road development plan" in brief.

Answer :

Model Paper-I, Q2(b)

Three road development plans are prepared by the Indian road congress, they are,

1. First twenty year road development plan or Nagpur road plan.
2. Second twenty year road development plan or Bombay road plan.
3. Third twenty year road development plan or Lucknow road plan.

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Third Twenty Year Road Development Plan

The third twenty year development plan was developed in 1981 and is given by the Road Wing of the Ministry of Shipping and Transport (RWMST). The RWMST was supported by various organisations and scholars of highway and transportation engineering fields. The document representing this plan was released at Lucknow while the golden jubilee celebrations of Indian Road Congress had been organized. The plan was prepared from the year 1981 and is assumed to end in 2001. As the plan was presented in the city of Lucknow, it is also known as "Lucknow Road Plan".

Objectives

The main objectives of preparing this plan are to enhance the facilities of transport in villages, towns etc. The other basic objectives include the energy conservation, retaining of environmental quality and road safety methods. The length of the road was proposed to increase from 15,02,700 km in 1981 to 27,02,000 km till the end of the plan. This eventually results in the increase of road density of 36 km/100 km². The third twenty year road development plan also changes the classification of roads given in Nagpur road plan. The roads according to this plan are classified as follows.

(i) **Primary System**

- (a) Expressways and
- (b) National Highways (NH)

(ii) **Secondary System**

- (a) State Highways (SH)
- (b) Major District Roads (MDR)

(iii) **Tertiary System**

- (a) Other District Roads (ODR)
- (b) Village Roads (VR).

Q20. Compare the Nagpur road plan and the Bombay road plan.

Answer :

Nagpur Road Plan		Bombay Road Plan	
1.	Two plan formulae was given, first formula to calculate the combined length of national highways, state highways and major district roads and the second formula was used to calculate the combined length of other district roads and village roads.	1.	Five plan formulae are given in this plan by which the length of each particular class of road can be obtained separately.
2.	The area is divided into two parts i.e., agricultural, and non-agricultural.	2.	The area is divided into three parts i.e., agricultural, semi-agricultural and un-cultivated area.
3.	The proposed road length was 16 km/100 km ² .	3.	The proposed road length was 32 km/100 km ² .
4.	The plan formulae did not consider a large population. They are just developed for population above 5000.	4.	The plan formulae considered the population upto 1,00,000 for length calculation.
5.	Railway track length is subtracted from the length of highway calculated.	5.	Railway track length is not deducted from the calculated length of highway.
6.	An allowance of 15% in the calculated length was made for future development.	6.	An allowance of 5% in the calculated length was made for future development.
7.	No expressways were proposed.	7.	Expressways of length of about 1600 km were proposed.

1.10

Q21. Explain in detail about the road development plan, vision 2021.

Answer:

To develop the existing roads, a document called vision 2021 is prepared by Indian roads congress.

The important features included in this plan are,

- The target for expanding the road network are,

Type of road Network	Achievement in km, (Till Year 2000)	Target (for 2021, in km)
Express ways	-	15,766
National Highways (NH)	57,700	80,000
State highways (SH)	124,300	160,000
Major District roads other district road and Village roads.	29,94,000	Target have not been suggested.

- Atleast half of the whole network of National highway should have four or six lanes and the rest should be composed of two-lane carriage way with hard shoulders.
- Minimum 10,000 km of state highways should consists of four lanes and the remaining have two lanes.
- At least forty percent of the major district roads should have two lane carriage ways.
- The existing road network should receive a proper attention for its maintenance and renovation.
- By maintaining proper engineering measures, the safety of roads should be enhanced.
- The engineers should be trained adequately.

Q22. Write a note on Rural Roads Development plan, vision 2025.

Answer:

Model Paper-III, Q2(b)

The salient features of rural road development plan, vision 2025 (i.e., a document prepared by Indian roads congress) is:

- The concept of core network which provides accessibility to each and every village should be brought out by preparing master plans for rural roads.
- All the habitations consisting of population above 100 should be connected by all weather roads.
- The existing rural roads are needed to be expanded and upgraded (about 1,237,000 km of length) at an estimated cost of Rs. 1,64,000 crores.
- To achieve full connectivity of rural roads on each and every village, an estimated length of 2,90,000 km of new roads will have to be laid.
- An estimated amount of Rs.7,500 crores will be required for the maintenance of rural roads.

Q23. Describe and compare the various road development plans in India.

Answer :

April-18, (R15), Q2(b)

For answer refer Unit-I, Q17, Q18, Q19, Q20.

Q24. Present on different road developments in India.

Answer :

May-16, (R13), Q2(a)

For answer refer Unit-I, Q17, Q18 and Q19.

1.3 CLASSIFICATION OF ROADS - ROAD NETWORK PATTERNS

Q25. Explain the classification of roads.

Model Paper-I, Q3(a)

OR

What are the various methods of classifying roads? Briefly outline the classification of urban roads.

May-17, (R13), Q3(b)

Answer :

Classification of Roads

Following are the classification of roads,

- Areawise classification of roads
- Structural classification of roads.

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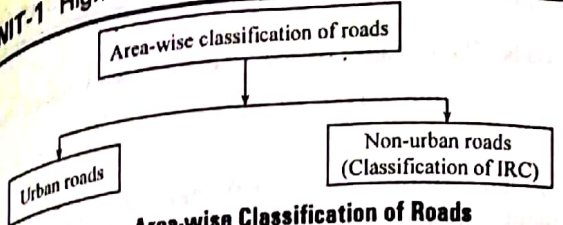


Figure: Area-wise Classification of Roads

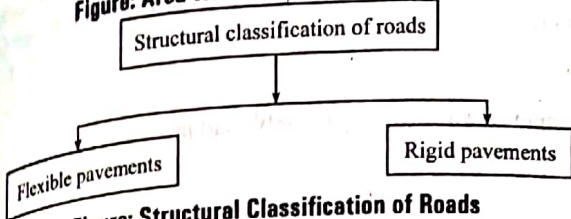


Figure: Structural Classification of Roads

Area-wise Classification of Roads.

- I. (a) Urban roads
- (b) Non-urban roads (classification of IRC).

Urban Roads

Urban roads are carried out in urban area. These roads are placed within the limits of municipalities and municipal corporation.

Urban roads are classified into following types,

- (i) Arterial
- (ii) Sub-arterial
- (iii) Collector street
- (iv) Local street.

Arterial

An arterial is a type of street used for through-traffic, normally on a continuous route. The existing expressway systems are connected by the arterial system to distribute and collect through-traffic from sub-arterial and collector street system. The continuity of the arterials is necessary for efficient movement of through-traffic. In arterial street, there is a restriction and regulation for parking, loading and unloading activities. Pedestrians are permitted to cross only at cross roads.

Sub-arterial

Sub-arterial is also used for carrying through-traffic, normally on a continuous route. The traffic mobility is less in sub-arterial.

Collector Street

A collector street is a street, which collects and distributes traffic from and to local streets. This street provides entrance to arterial streets. Collector street may be situated in residential areas and industrial areas. In collector street, there are some restrictions for parking.

Local Streets

Local street is a street, which is an entrance to residential areas and business areas. Based on the main use of the adjoining land, the local streets may be located in residential, commercial or industrial areas. These are no restrictions for parking and movement of pedestrians.

Non-Urban Roads (Classification of IRC)

Non-urban roads are carried out in connected areas.

These roads are placed other than the limits of municipalities and municipal corporation.

Non-urban roads are classified into following types,

- (i) National highways
- (ii) State highways
- (iii) Major district roads
- (iv) Other district roads
- (v) Village roads.

(i) National Highways

National highways are the main highways, which runs through the length and breadth of the country associating major ports, foreign high ways, state capitals, large industrial and tourist centres. Currently, there are 55 national highways, which are identified as NH1, NH2, etc. National highways are maintained by the central government.

(ii) State Highways

State highways are the roads connecting the district headquarters and essential cities within a state and these are associated with national highways.

(iii) Major District Roads

Major district roads are essential roads within a district which serves areas of production and markets. These are connected with the national highways.

(iv) Other District Roads

These roads connects the rural areas with market centers, tahsil headquarters, block mandal development headquarters or other main roads.

(v) Village Roads

Village roads are the roads, which connects villages or group of villages with the nearest roads of a higher group.

2. Structural Classification of Roads

These are classified into two types,

- (a) Flexible pavements
- (b) Rigid pavements.

(a) Flexible Pavements

Flexible pavements is subjected to elastic deformation and it is adjusted to normal loading.

These are divided into following types,

- (i) Earthen road and gravel roads
- (ii) W.B.M roads
- (iii) B.T roads.

(i) Earthen Road and Gravel Roads

These roads are also known as low cost roads or unmetalled roads or kucha roads. These roads are helpful for the villages where the population is less and also helpful for transportation of light loaded and pedestrians.

(ii) **W.B.M Roads**

W.B.M roads are also known as metalled roads or untreated roads. These roads provide a link between villages, main villages and other district roads.

(iii) **B.T Roads**

These roads are also called as modern roads, or superior roads or high costs roads, in which the bitumen is used as binder material. These roads provide a link between major villages, mandal headquarters, other important towns in the district and these are connecting to national highways, state highways etc.

(b) **Rigid Pavements**

To withstand deformation under normal loading, the rigid pavements act as beams. The only road falls under this category is as follows,

Cement Concrete Roads

These cement material is used as binder in cement concrete roads. Generally, these roads are laid in water lagged areas.

Q26. Draw neat sketches of various road patterns. Explain the concept of radial or star and grid pattern.

Model Paper-II, Q3(a)

OR

List the various types of road patterns.

May-17, (R13), Q1(a)

OR

What are the different road network patterns and explain their benefits?

May-16, (R13), Q2(b)

Answer :

Types of Road Patterns

The different types of road patterns are as follows,

- (a) Rectangular or block pattern
- (b) Radial or star and block pattern
- (c) Radial or star and circular pattern
- (d) Radial or star and grid pattern
- (e) Hexagonal pattern
- (f) Minimum travel pattern.

(a) **Rectangular or Block Pattern**

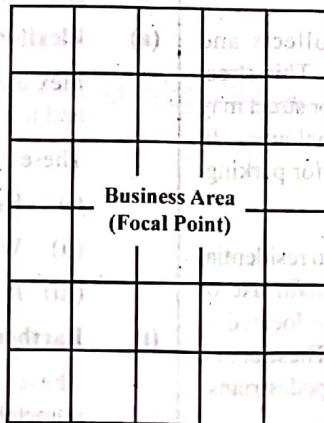


Figure: Rectangular Pattern

(b) Radial or Star and Block Pattern

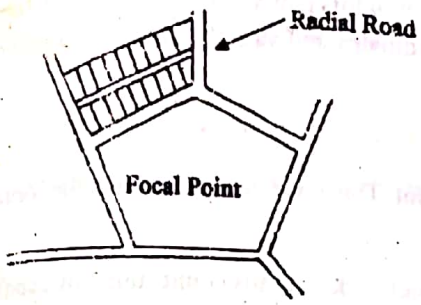


Figure: Radial or Star and Block Pattern

(c) Radial or Star and Circular Pattern

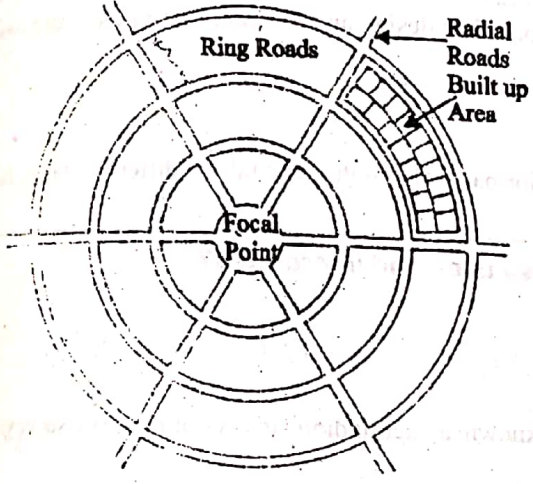


Figure: Radial or Star and Circular Pattern

(d) Radial or Star and Grid Pattern

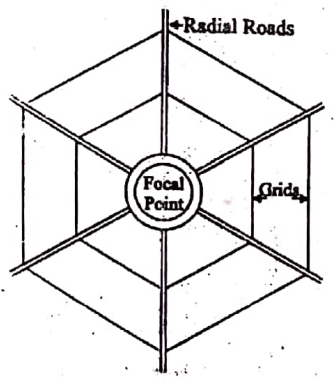


Figure: Radial or Star and Grid Pattern

(e) Hexagonal Pattern

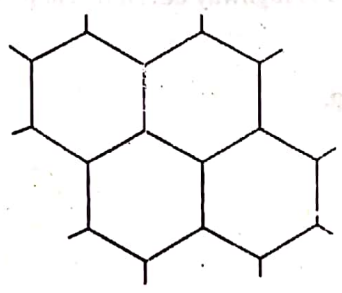


Figure: Hexagonal Pattern

(f) Minimum Travel Pattern

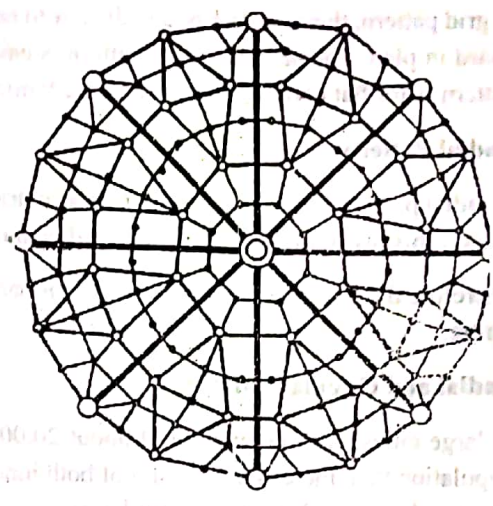


Figure: Minimum Travel Pattern

Concept of Radial or Star and Grid Pattern

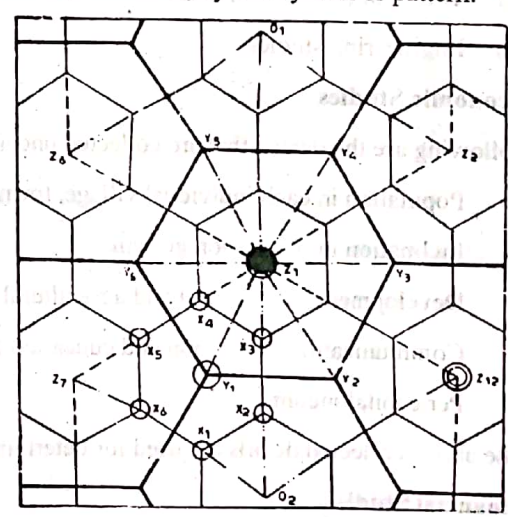
Let, V_1, V_2, V_3, \dots be the all villages in specific area.

T_1, T_2, T_3, \dots be the towns of this area.

C_1, C_2, C_3, \dots be the cities.

The small star and grid pattern between points V_1, V_2, V_3 etc., is formed when the points V_1, V_2, V_3 are joined and for these points (i.e., V_1, V_2, V_3), the points T_1, T_2, T_3 act as focal points.

The bigger star and grid pattern is developed when the points T_1, T_2, T_3 etc., are joined and for these points (i.e., T_1, T_2, T_3), the points V_1, V_2, V_3 act as focal points. Thus, the total area can be covered by such various radial or star and grid pattern. The inter-communication facilities are provided to all villages, towns and big cities etc., by this system or pattern.



$X_1, Y_1 = \text{MOR/ODR}$ X - Village
 $Y_1, Y_2 = \text{MOR/SH}$ Y - District head quarter/ Town
 $(Z_1, Z_2), (Z_1, Y_1) = \text{SH/NH}$ Z - State capital/Big city
 O - National capital/
 Metropolitan city

Figure: Concept of Star and Grid Pattern

1.14

(a) Grid Pattern

In grid pattern, the roads are perpendicular to each other. The arrangement of this pattern is done to portray the chequered board in plan. The set out of this pattern is easy using rectangular coordinates and straight lines. The suitability of this pattern is for flat country without any predominant natural features.

(b) Radial Pattern

In radial pattern, ring roads spring from a central civic called as focal point. This civic centre can be in the form of palace, market, historical monuments, public office building etc.

Therefore the development of this system is carried out in the form of a network of roads connecting town centre to town centre.

(c) Radial and Circular Pattern

In large cities, with population of about 20,000 should have a single inner-outer ring road. If the city has 0.1 million population then there is a necessity of both inner and outer ring road. The design and location of ring roads are based on the size, layout and usage of central area.

(d) Star and Grid Pattern

This pattern is majorly used for highways which connect the major parts of country, capitals of different states, foreign highways etc.

Q27. What are the uses of fact finding surveys? How are these used and interpreted?

Answer :

Fact Finding Surveys

The field surveys that are used for collecting the factual data are known as fact finding surveys or planning surveys.

It consists of the following studies,

- (a) Economic studies
- (b) Financial studies
- (c) Traffic or road use studies
- (d) Engineering studies.

(a) Economic Studies

Following are the details that are collected under this study,

1. Population in each individual village, town or other locality.
2. Inclination in population growth.
3. Development of industrial and agricultural sector.
4. Communication, recreation and education facilities.
5. Per capital income.

The above collected details are used for determining the economics related to highway development programme.

(b) Financial Studies

Under financial studies, the details that are collected includes the following,

1. Income sources and predicted revenue from road tax.
2. Standards of living.
3. Development in financial aspects.

These details are used for studying the different aspects such as income sources and utilization of project funds.

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Traffic or Road Use Studies

(c) Following are the details that are collected in traffic or road use studies,

1. Volume of traffic (vehicles/day).
2. Studies related to origin and destination.
3. Patterns of traffic flow.
4. Causes and prevention of accidents.
5. Facilities for mass transportation.

In order to bring about a change in a plan, complete details of the current traffic (volume and flow pattern) is to be known which can be estimated easily from the above obtained data.

Engineering Studies

(d) The details to be collected under engineering studies include,

1. Topographic and soil surveys.
2. Road location and classification.
3. Studies with reference to road life.
4. Traffic studies.
5. Drainage problems
6. Construction and maintenance of roads.

The above collected factual data are used for investigating the scientific plan or programme.

1.4 HIGHWAY ALIGNMENT – FACTORS AFFECTING ALIGNMENT

Q28. Discuss in detail, the various factors controlling the highway alignment with sketches.

(May-17, (R13), Q2(a) | Model Paper-III, Q3(a))

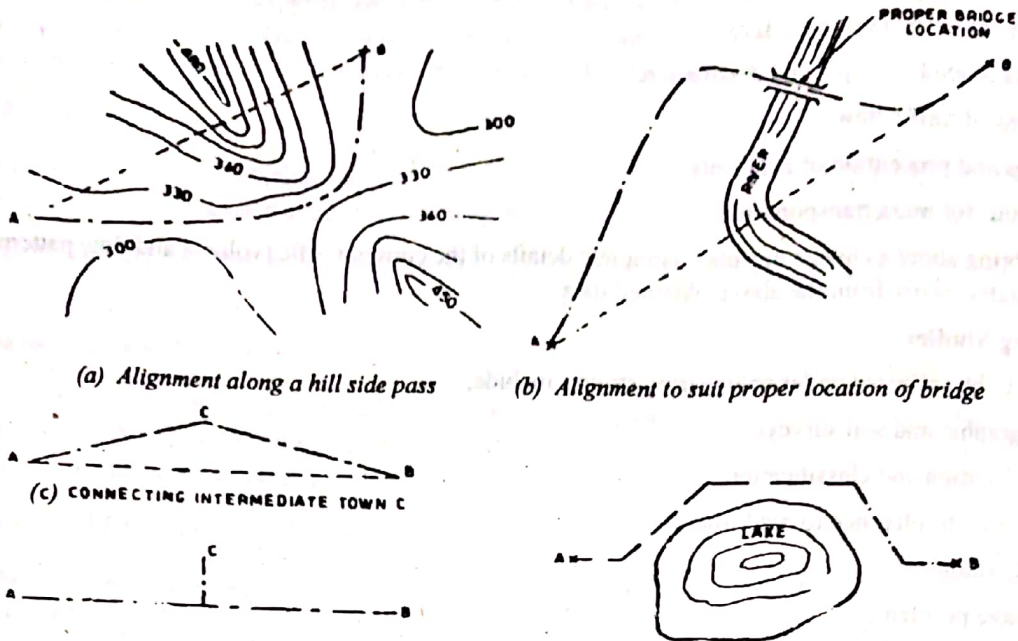
Answer :

Alignment

In order to keep the alignment minimised, the two road terminals should be straight which is not possible all the times because of various obstructions and topography. A road which is most economical in initial construction cost, may not be economical in maintenance and vehicle operational cost and a road which is more economical in the view point of maintenance and vehicle operation cost need not be economical in the point of construction. So alignment can fulfill both the requirements simultaneously.

Various Factors Controlling the Alignment of Roads

1. The alignment of road should be done in such a way that it avoids obstructions such as hospitals, places of worship, schools and playgrounds to avoid accidents.
2. The alignment of road should facilitate easy gradients and smooth curves.
3. The alignment should avoid crossing the towns, villages, agricultural lands, gardens, etc., as land acquisition is costly and damages the public property.
4. The alignment should cross a river only at a place which is the most suitable for bridge site.
5. The alignment should avoid hilly region and thick forest which may increase the cost of the project and to avoid discomfort and delays due to traffic.
6. Frequent crossing of railway lines or bridges should be avoided.
7. The alignment should be such that it has minimum earth work for formation and minimum cutting.
8. The alignment should be such that the required materials for construction and maintenance should be available in nearby region.
9. It should connect as many places as possible.
10. It should avoid unnecessary zigzag alignment.
11. It should avoid a number of bends and sharp curves.
12. A good vicinity on horizontal and vertical curves is very important to avoid accidents for fast moving vehicles.
13. The alignment should pass through scenic beauty for the recreation of passengers in journey.



Q29. Discuss the general principles in the re-alignment of a highway and explain how the work is carried out.

Model Paper-II, Q2(b)

OR

What is the necessity of Realignment? List and explain the various steps in Realignment.

May-17, (R13), Q2(b)

Answer :

The general principles in the re-alignment of a highway are as follows,

1. The improvement of the horizontal alignment increases the available sight distance. If the obstruction is removed or shifted from inner side of the curve to the appropriate extent, then the set back distance increases at horizontal curves. The improvement of transition curve is highly expensive. Therefore, the rectification of the defects should be done where ever required.
2. The overtaking sight distance at summit curves should be provided during the improvement of vertical alignment. It is generally preferred to provide suitable vertical transition curves in order to achieve shock-free movement of vehicles that travel at desired speeds. Proper care should be taken while checking the comfort condition and also the visibility under the head lights of the vehicles that travel during nights.
3. When the road is submerged under water for short duration of time, it stretches. Therefore, prior to strengthening or widening pavement section, the roads should be raised appropriately. Proper methods should be implement against water-logging.
4. The site selection for major bridges depend on the following factors,
 - (a) River training works
 - (b) Conditions of sub-soil for foundation and hydraulic assumptions.

In case of small bridges, the selection of bridge site is influenced by the road alignment.

5. If over-bridges or under bridges for a national highway across a railway level crossing is to be constructed, then the product of number of gate closures and traffic intensity on highway (tonnes per day in the design year) is generally considered. The location is selected with reference to highway alignment, topographic and other conditions of site.
6. The origin and destination studies are generally required for providing alternate routes to bypass through traffic.

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Q30. What are the factors effecting highway alignment.

(May-16, (R13), Q1(b) | Model Paper-I, Q3(b))

OR

What are the factors effecting highway alignment? Discuss in detail.

April-18, (R15), Q3(a)

Answer :
The different factors affecting the highway alignment are as follows,

1. Obligatory points
2. Traffic
3. Geometric design
4. Economics
5. Other assumptions.

Obligatory Points (Control Points)

The obligatory points are the controlling points that govern the alignment of highways.

Traffic

The alignment should satisfy the requirements of traffic. In the alignment of new road, the expected lines, traffic flow patterns are to be considered.

Geometric Design

- (i) The geometric design of highway deals with the arrangement of dimensions and layouts of highway elements like alignment, sight and intersections.
- (ii) The geometric design of highway provide maximum efficiency in traffic operations along with greatest safety at suitable cost.

Economy

The considered alignment with respect to the above factors should be economical. By avoiding high embankments and deep cuttings, initial cost of construction can be reduced. The alignment is selected in a way to counter balance the cutting and filling.

Other Assumptions

The other factors which control the alignment are as follows,

- (a) Drainage considerations
- (b) Hydrological factors
- (c) Political considerations
- (d) Monotony.

1.5 ENGINEERING SURVEYS – DRAWINGS AND REPORTS – HIGHWAY PROJECT

Q31. What are the various surveys to be carried out before planning a highway system for a given area? Explain briefly.

Model Paper-II, Q2(a)

OR

Present on Engineering surveys to be conducted for highway construction.

May-16, (R13), Q3(a)

Answer :

Various Surveys to be Carried Out Before Planning

Routing the locations or alignment of highway has to be carried out in the following four stages of surveys,

- (i) Map study
- (ii) Reconnaissance survey
- (iii) Preliminary survey
- (iv) Final location and detailed survey.

Map Study

The possible routes of the road can be suggested with the help of topographic maps. These maps are available with a

counter interval of 15 to 30 m in India. It consists of hills, valleys, plains, rivers, etc.

Data Required for Alignment on a Map

1. Location of bridge site for crossing river.
2. Alignment avoiding valleys, ponds or lakes.
3. To obtain the length of road between two consecutive terminals by keeping the gradient within the allowable limit.
4. To check whether any road is to cross a row of hills, possibility of crossing through mountain pass.

(ii) Reconnaissance

The main aim of this survey is to examine the general character of the area so that most feasible routes can be determined. This kind of survey is meant for new road or bypass road constructed to avoid a certain area. This method is not suitable for improvement of an existing road. The reconnaissance survey is conducted in the following methods,

1. Study of topographical survey sheets, geological maps, aerial photographs, mythological maps, if available.
2. Ground reconnaissance
3. Aerial reconnaissance.

(iii) Preliminary Survey

The main purpose of preliminary survey is to collect all the physical information for a highway along the route selected on the basis of reconnaissance survey. It contains a traverse along a proposed new route and along the existing road for improvement of roads planned.

During this survey, the features taken into account along the traverse are topographical features, worship places, graveyards or burial grounds, etc. In this method a high degree of accuracy is maintained.

Reports to be Collected in Preliminary Survey

1. Ground levels to the extent.
2. Houses, sheds, buildings, commercial and industrial towers along the alignment.
3. All the road maps
4. Fences, walls and other boundary lines.
5. Railway crossings and railway lines.
6. Existing drainage system.
7. Natural and artificial water resources if any.
8. All other particulars of site which effect the final location.

(iv) Final Location and Detailed Survey

The main purpose of final location and detailed survey is to layout final locations of roads according to alignment selected by the designing members. In this survey, all the data required for working, drawing are collected. This survey is carried out in two stages, namely,

1. Staking (making) of the final centre line of the road with the help of theodolite instruments.
2. Detailed levelling.

Q32. Present the different drawings to be developed for facilitating to construct a highway.

May-16, (R13), Q3(b)

OR

What are the various engineering drawings necessary for implementing a highway project? What are their recommended scales?

Answer :

April-18, (R13), Q3(b)

The following are the types of drawings used in preparation of high way project,

1. Key map - It represents proposed and existing roads and also various important places.
2. Index map - It represents topographic characteristics of a particular area.
3. Preliminary survey plans - It gives information about various alternate alignments.
4. Detailed plans - It provides complete plan including alignment, boundaries, contours and also existing structures.
5. Longitudinal sections - It indicates details of datum line, drainage crossings etc.

6. Detailed cross section
7. Land acquisition plan
8. Cross drainage drawings
9. Drawings of road intersections
10. Plans showing quarries.

Q33. Write a short note on highway project reports.

Model Paper-III, Q3(b)

Answer :

Highway Project Reports

The main aim of project reports is to investigate the possibility of the bypass road for the central business district of a city. Highway project reports are based on the various surveys conducted for the alignment of new roads various steps to be followed in investigation are as follows,

- (i) Map study
- (ii) Reconnaissance
- (iii) Cross sectional surveys to be carried out on both the sides of proposed alignment of all points where longitudinal levels are considered. These levels are taken at 10 meters intervals.
- (iv) Block levelling is to be carried out at every 10 m grid wherever water is encountered.

All the data is collected from various surveys and it is analysed and make necessary changes according to topography in the design of horizontal curves. By fixing the formation levels and the gradients, it is preferred to keep the road formation level above the ground level. It is to be noted that the gradients should be flat and the amount of cutting should be equal to the amount of filling.

The following information should be included in the highway project reports,

- (a) Name of the work
- (b) Authority dealing with the project
- (c) Necessity of the work
- (d) Traffic
- (e) Terrain and climatic conditions
- (f) Details of the existing road and improvements proposed
- (g) Provisions made in the estimate
- (h) Materials and manpower availability
- (i) Rates, standards and specifications
- (j) Agency or contractors of execution
- (k) Period of completion of project.

Q34. What are obligatory points? How do they influence highway alignment? Explain with the help of neat sketches.

Answer :

Obligatory Points

Obligatory points are the control points which govern the alignment of highways. These points are classified into two different types,

- (a) Points with alignment
- (b) Points with non-alignment.

(a) Points with Alignment

The road alignment passing through obligatory points may cause the alignment to diverge from the shortest path. The examples are mountain pass, bridge site and intermediate town.

If mountains, high ridges or hill range comes across, then the different alternatives is to cut the tunnel or to diverge until a hill pass comes or to go round the hills. The alternatives are suitable based on the site conditions, topography and cost considerations. The deviation of straight line AB along the hill side pass, avoiding heavy cutting is shown in figure (i),

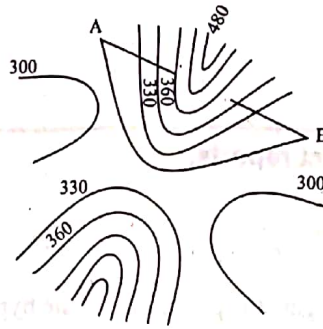


Figure (i): Alignment Along a Hill Side

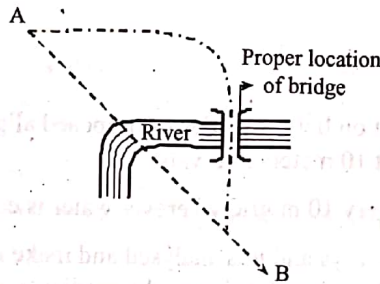


Figure (ii): Alignment Suitable for Proper Location of Bridge

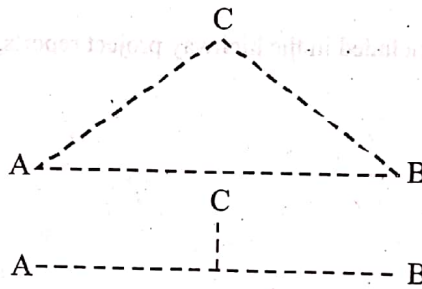


Figure (iii): Alignment for Connecting Intermediate Town



Figure (iv): Alignment for Avoiding an Intermediate Area

The location of the road bridge across a river is selected where the pier and bridge abutment is suitably founded and where the path of river is straight and permanent. The straight alignment in between the station *A* and station *B* at proper location of bridge is shown in figure (ii).

It is desirable to connect villages, intermediate towns and other places during the alignment of road between two stations. Figure (iii) represents the shifting of straight alignment *AB* along line *ABC* for connecting the intermediate station '*C*'.

(b) Points with Non-alignment

There is a deviation of road from the proposed shortest alignment due to points with non-alignment. The religious places, expensive structures and unsuitable land etc., are some of the obligatory points which are to be avoided during the alignment of road.

An alignment is also deviated when lake, pond or valley come in between the path of straight alignment.