IAT-1 - SOLUTIONS
Transportation Engineering-I (10CV56)
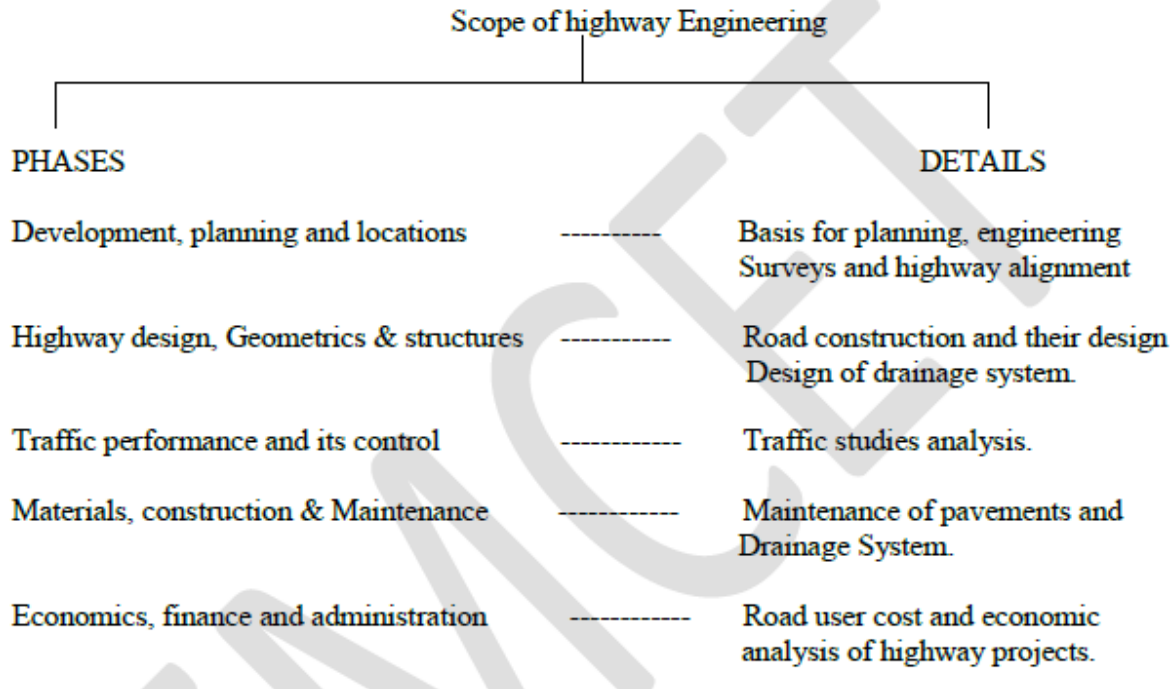
Q1.(a)What is Jayakar Committee and what are its recommendations ?

Ans:- Over a period after the First World War, motor vehicles using the roads increased and this demanded a better road network which can carry mixed traffic conditions. The existing roads when not capable to withstand the mixed traffic conditions. For the improvement of roads in India government of India appointed Mr. Jayakar Committee to study the situations and to recommend suitable measures for road improvement in 1927 and a report was submitted in 1928 with following recommendations:

1) Committee found that the road development of the country has become beyond the capacity of local governments and suggested that Central government should take the proper charge considering it as a matter of national interest.

2) They gave more stress on long term planning programme, for a period of 20 years (hence called twenty year plan) that is to formulate plans and implement those plans within the next 20 years.

3)One of the recommendations was the holding of periodic road conferences to discuss about road construction and development. This paved the way for the establishment of a semi-official technical body called Indian Road Congress (IRC) in 1934.

4)The committee suggested imposition of additional taxation on motor transport which includes duty on motor spirit, vehicle taxation, license fees for vehicles plying for hire. This led to the introduction of a development fund called Central road fund in 1929. This fund was intended for road development.

5)A dedicated research organization should be constituted to carry out research and development work. This resulted in the formation of Central Road Research Institute (CRRI) in 1950.

Q1.(b)Briefly explain the scope of highway engineering.

Ans:-

Scope of highway Engineering

PHASES		DETAILS
Development, planning and locations	----------	Basis for planning, engineering Surveys and highway alignment
Highway design, Geometrics & structures	-----------	Road construction and their design Design of drainage system.
Traffic performance and its control	------------	Traffic studies analysis.
Materials, construction & Maintenance	-----------	Maintenance of pavements and Drainage System.
Economics, finance and administration	------------	Road user cost and economic analysis of highway projects.

Q2.(a).List the salient features of third road development plan.

Ans:- The major policies and objectives of this road plan are listed below:
a) The future 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.

Q2.(b)With a neat sketch explain rectangular pattern of roads.

Ans:-
Rectangular or block pattern: In this, entire area is divided into rectangular segments having a common central business and marketing area. This area has all the services located in the central place. This pattern is not convenient or safe from traffic operation point of view and it results into more number of accidents at intersections. Eg: Chandigarh city.

Q3.(a) What are the conditions which necessitate taking up a realignment project of a highway?

Ans:- The realignment of existing roads may be necessary in the following cases:

➢ Improvement of horizontal alignment design elements such as radius, super elevation, transition curve, clearance on inner side of the curve of shifting the curve to provide adequate sight distance, elimination of reverse curves and undesirable zig-zags etc.

➢ Improvement of vertical alignment design elements like steep gradients, changes in summit curves to increase sight distance, correction of undesirable undulations like humps and dips etc.

➢ Raising the level of a portion of a road which is subjected to flooding, submergence or waterlogging during monsoons.

➢ Re-construction of weak and narrow bridges and culverts and changes in waterways at locations slightly away from the existing site.

➢ Construction of over bridges or under bridges at suitable locations across a railway line in place of level crossing or across another road to provide grade separate intersection.

➢ Re-alignment required due to a portion of a road being submerged under water at the reservoir area on account of construction of a new dam.

➢ Construction of a bypass to avoid the road running through a city or town.

➢ Defence requirements.

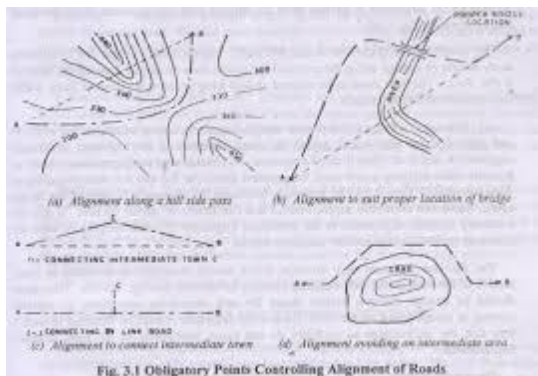**Q3(b).Explain obligatory points. With neat sketches explain how these control the alignment.**

Ans:- Obligatory Points: -These control points may be divided in to two categories:
i) Points through which the alignment is to pass
ii) Points through which the alignment should not pass.
Obligatory points through which the road alignment has to pass may cause the alignment to often deviate from the shortest (or) easiest path. In fig.1.shows how the straight alignment AB is deviated along the hillside pass, thus avoiding a tunnel (or) heavy cutting. Fig.2.shows that the straight alignment between stations A and B which passes across the river band is to be deviated along the path shown in order to cross the river at a proper bridge location.

ii) Obligatory points through which the road should not pass also may make it necessary to deviate from the proposed shortest alignment. The obligatory points, which should be avoided while aligning a road, include religious places, very costly structures.
However if there is no alternative and the alignment has to be taken across such an area, the construction and maintenance costs are likely to be very high.

Fig. 3.1 Obligatory Points Controlling Alignment of Roads

Q4(a).Explain briefly the contribution of the following in road development in India:

1)IRC   (2) CRRI

Ans:- 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.
It is a semi-official technical body formed in 1934. It was formed to recommend standard specifications. It was constituted to provide a forum of regular technical pooling of experience and ideas on all matters affecting the planning, construction and maintenance of roads in India. IRC has played an important role in the formulation of the 20-year road development plans in India. Now, it has become an active body of national importance controlling specifications, guidelines and other special publications on various aspect of Highway Engineering.

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.

Q4(b). Explain the role of transportation in the development of the country.
Ans:- Transportation is vital for the economic development of any region since every Commodity produced whether it is food, clothing, industrial products or medicine needs transport at all stages from production to distribution. In the production stage transportation is required for carrying raw materials like seeds, manure, coal, steel etc. In the distribution stage Transportation is required from the production centres viz; farms and factories to the marketing centres and later to the retailers and the consumers for distribution These above are some of the necessities which make us to use transportation. The importance and adequacy of transportation system of a country indicates its economic and social development.
Economic Activity: Two important factors well known in economic activity are:
Production or supply and Consumption for human wants or demand.

Social Effects: The various social effects of transportation may be further classified into:
Sectionalism and transportation, Concentration of population into urban area & aspect of safety, law and order.
Q5(a).Discuss the various factors affecting highway alignment.

Ans:- The various factors, which control the highway alignment, in general may be listed as:
• Obligatory points
• Traffic
• Geometric design
• Economics
• Other considerations

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ii) Obligatory points through which the road should not pass also may make it necessary to deviate from the proposed shortest alignment. The obligatory points, which should be avoided while aligning a road, include religious places, very costly structures.
However if there is no alternative and the alignment has to be taken across such an area, the construction and maintenance costs are likely to be very high.
2)Traffic: - The alignment should suit traffic requirements origin and destination study should be carried out in the area and the desire lines be drawn showing the trend of traffic flow.
**3)Geometric design: -**
• Geometric design factors such as gradient, radius of curve and sight distance also would govern the final alignment of the highway.
• The absolute minimum sight distance, which should invariably be available in every section of the road, is the safe stopping distance for the fast moving vehicles.
4)Economy: -
• The alignment finalized based on the above factors should also be economical.
• The initial coast of construction can be decreased if high embankments and deep cuttings are avoided and the alignment is choosing in a manner to balance the cutting and filling.
5)Other considerations: -
• 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.
• In a flat terrain it is possible to have a very long stretch of road, absolutely straight without horizontal curves.

Fig. 3.1 Obligatory Points Controlling Alignment of Roads
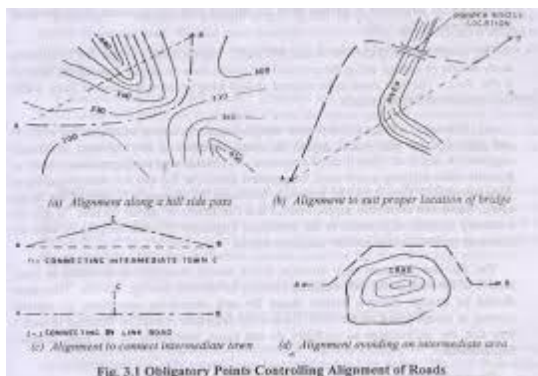
Q5(b). What are the ideal requirements of a highway?

Ans:- The ideal requirements of a highway are:

(1) Short: The alignment must be the shortest of the various alternatives available. The shortest path between any two points is a straight line but the topography of the area or other factors may necessitate it do divert and take some other route, but as far as possible it should be kept minimum.

(2) Easy: Alignment should be such that the road must be easy to construct and easy to maintain or repair. If curves are of large radius and the gradient is gentle it would be easy to construct the road, rather than opposite.

(3) Safe: Safety is again the basic requirement of the highway alignment and special care must be taken to align the road in such a way that it must have the safe or minimum Sight distances and Radius of the curves, means the geometrical design features like Sight Distance, Radius of the curves and the gradient of the road must be given special attention.

(4) Economical: Road alignment must be designed to have the initial cost of construction, maintenance cost and the vehicle operation cost to a minimum. Also the locally available materials should be checked before and it may decrease the over all cost. There must be a balance in the cutting and filling on the alignment of the road.

Q6(a). Define master plan and explain saturation system.
Ans:- Master Plan:-
Master plan is referred to as road development plan of a city; district or a street or for whole country. It is an ideal plan showing full development of the area at some future date. It serves as the guide for the plan to improve some of the existing roads and to plan the network of new roads. It helps in controlling the industrial, commercial and agricultural and habitat growth in a systematic way of that area. It gives a perceptive picture of a fully developed area in a plan and scientific way.

Saturation System:-
In this system optimum road length is calculated for an area based on the concept of attaining maximum utility per unit length of the road. This is also called as maximum utility system. Factors to attain maximum utility per unit length are:
1) Population served by the road network
2) Productivity (industrial and agricultural) served by the road network.
The various steps to be taken to obtain maximum utility per unit length are:
Population factors or units: Since, the area under consideration consists of villages and towns with different population these are grouped into some convenient population range and some reasoning values of utility units to each range of population serve are assigned.
Population less than 500, utility unit = 0.25
501 to 1001, utility unit = 0.50
Productivity Factors or units: The total agricultural and industrial products served by each road system are worked out and the productivity served may be assigned appropriate values of utility units per unit weight.
Optimum Road length: Based on the master plan the targeted road length is fixed for the country on the basis of area or population and production or both. And the same may be taken as a guide to decide the total length of the road system in each proposal.

Q6(b).The area of a certain district in India is 13,400 sq.km and there are 12 towns as per 1981 census. Determine the lengths of different categories of roads to be provided in this district by 2001.
Ans:-
1. NH in km = 13400/50 = 268km

2. SH in km

    a. By area 13400/25 = 536km

    b. By area and no of towns = 62.5*12 – 13400/50 = 382km
    Adopt 536km

3. MDR in km

    a. By area 13400/12.5 = 1072km

    b. By area and no of towns = 90*12 = 1080km

    Adopt 1080km

4. Total length of road network as per 2001 per 100sqm is

(NH+SH+MDR+ODR+VR)= 13400*(82/100) = 10988km
Length of NH+SH+MDR = 1884 km
Length of ODR & VR = 9104 km

Q7. Four new road links are to be constructed during a five year plan period. Suggest the order of priority for phasing the road construction program based on maximum utility approach. Assume utility units of 0.5, 1.0, 2& 4 for four population ranges& 1 per 1000 tonnes, 500 tonnes & 100 tonnes of agricultural, raw material & industrial products respectively.

Road link	Length, Km	No: of villages served with population range				Productivity served in tonnes		
		<500	501-1000	1001-2000	>2000	Agricultural	Raw material	Industrial
A	70	30	18	8	3	250	200	100
B	45	11	7	6	3	320	250	160
C	65	23	7	5	5	500	400	220
D	60	28	4	3	3	400	350	50

Ans:-

Road A= 30*.5+ 18*1+ 8*2+ 3*4+0.25+0.40+ 1.0 = 62.65 / 70 = 0.895   1st

Road B= 11*.5+ 7*1+ 6*2+ 3*4+0.32+0.50+1.6 = 38.92/45 = 1.61   2nd

Road C = 23*.5+ 7*1+ 5*2+ 5*4+0.50+0.80+ 2.2 = 52/65= 3.59   3rd

Road D = 28*.5+ 4*1+ 3*2+ 3*4+0.40+0.70+0.50 = 37.6/60= 3.59   4th