USN :

CMR Institute of Technology, Bangalore
DEPARTMENT OF CIVIL ENGINEERING
I - INTERNAL ASSESSMENT

Semester: 6-CBCS 2017
Subject: HIGHWAY ENGINEERING (17CV63)
Faculty: Ms Divya Viswanath

Date: 20 May 2021
Time: 09:00 AM - 10:30 AM
Max Marks: 50

Instructions to Students :

Answer all Questions

Answer All Questions

<table>
<tr><th colspan="2">Q.No</th><th></th><th>Marks</th><th>CO</th><th>PO</th><th>BT/CL</th></tr>
<tr><td>1</td><td>a</td><td>What are the objectives of
(a) IRC
(b) CRRI</td><td>6</td><td>CO1</td><td>PO1,PO3,PO8,PO9</td><td>L2</td></tr>
<tr><td></td><td>b</td><td>Briefly explain the classification of urban roads.</td><td>4</td><td>CO1</td><td>PO1,PO3,PO8,PO9</td><td>L1</td></tr>
<tr><td>2</td><td>a</td><td>Write short note on:
(a) NHDP
(b) KSHIP and its projects</td><td>6</td><td>CO1</td><td>PO1,PO3,PO8,PO9</td><td>L2</td></tr>
<tr><td></td><td>b</td><td>Explain the saturation system of road planning.</td><td>4</td><td>CO1</td><td>PO1,PO3,PO8,PO9</td><td>L1</td></tr>
<tr><td>3</td><td>a</td><td>Four new road links A, B. C & D are to be constructed during a 5 year plan period. Suggest the order of priority for phasing the road construction based on maximum utility approach. Assume utility units of 0.5,1.0,2.0 & 4.0 for the population ranges and 2, 2 & 5 units per 1000 T of agricultural, raw material and industrial products from the following data:
<table>
<tr><th rowspan="2">Road link</th><th rowspan="2">length (Km)</th><th colspan="4">No: of villages served with population range</th><th colspan="3">Productivity served</th></tr>
<tr><th>< 500</th><th>501-1000</th><th>1001-2000</th><th>>2000</th><th>Agricultural</th><th>Raw materials</th><th>Industrial products</th></tr>
<tr><td>A</td><td>75</td><td>30</td><td>15</td><td>10</td><td>3</td><td>8000</td><td>3000</td><td>1000</td></tr>
<tr><td>B</td><td>35</td><td>20</td><td>08</td><td>06</td><td>3</td><td>5000</td><td>1000</td><td>1600</td></tr>
<tr><td>C</td><td>40</td><td>15</td><td>06</td><td>05</td><td>5</td><td>6000</td><td>2000</td><td>3200</td></tr>
<tr><td>D</td><td>50</td><td>40</td><td>04</td><td>03</td><td>2</td><td>3000</td><td>7000</td><td>500</td></tr>
</table></td><td>8</td><td>CO1</td><td>PO1,PO3,PO8,PO9</td><td>L3</td></tr>
<tr><td></td><td>b</td><td>Define master plan in highway engineering.</td><td>2</td><td>CO1</td><td>PO1,PO3,PO8,PO9</td><td>L1</td></tr>
<tr><td>4</td><td>a</td><td>What are the main objectives of preliminary survey and list the steps followed in the preliminary survey by conventional approach.</td><td>5</td><td>CO2</td><td>PO1,PO2,PO3,PO7,PO8,PO9</td><td>L2</td></tr>
<tr><td></td><td>b</td><td>Briefly explain the reconaissance survey in the alignment of a highway project.</td><td>5</td><td>CO2</td><td>PO1,PO2,PO3,PO7,PO8,PO9</td><td>L2</td></tr>
<tr><td>5</td><td>a</td><td>Explain the steps involved in new highway project.</td><td>5</td><td>CO2</td><td>PO1,PO2,PO3,PO7,PO8,PO9</td><td>L2</td></tr>
<tr><td></td><td>b</td><td>Briefly explain the factors controlling highway alignment.</td><td>5</td><td>CO2</td><td>PO1,PO2,PO3,PO7,PO8,PO9</td><td>L2</td></tr>
</table>

IAT-1-SOLUTION

HIGHWAY ENGINEERING-17CV63

1.a.

IRC:-

• IRC was formed in the year 1934.

• The main objectives are:

(a) to provide forum for regular pooling of experience and ideas on all matters that effect the planning, construction and maintenance of roads in India, and
(b) to recommend standard specifications to provide a platform for the expression of professional opinion on matters relating to road engineering.

• It publishes journals, research publications**,** standard codes, specifications, guide lines and other special publications on various aspects of highway engineering.

• Provides a platform for expression of professional opinion on matters relating to roads and road transport.

• Played an important role in the formation of three road development programs in India.

• It works in close collaboration with Roads Wing of the Ministry of Transport.

CRRI

CRRI was formed in the year 1950 at New Delhi.

• The main objectives of CRRI 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.
vi)To develop labor intensive methods and manual aids for the construction of low-cost all-weather roads.

1.b.

The urban roads are classified as per their importance such as:
I. Arterial roads II. Secondary or sub-arterial roads III. Collector streets IV. Local streets
Arterial Roads:- These are that roads which connect the town to state highway or a national highway. They pass through the city limits and carry a large amount of traffic and therefore should be planned as straight as possible, avoiding sharp curves. These should not enter into the heart of the city at any cost, should have very few road junctions, which should be controlled by roundabouts or fly-overs. They should have no obstructions such as frontage of buildings, loading or unloading areas, parking places, and pedestrians on the carriage way.

Secondary or Sub-arterial Roads:- Also known as major roads they run within the limits of the town connecting its important centres. They are designed for slow moving traffic and cover a

short distance. The sub- arterial roads act as a link between the arterial roads and local roads. The sub-arterial roads should be improved and provided with safety measures at intersections.
Local streets:- These roads, also known as minor roads, are meant to provide approach to the buildings, officers, shops, schools, colleges etc. There should be no through traffic here and so the local roads are not linked with the arterial roads. These roads are used for residential units, shopping and business centres.
Collector streets:- These are meant for collecting the traffic from local streets to arterial streets. Full access is allowed into collector streets from the properties alongside. It is situated in residential, industrial and commercial areas. These streets have few parking restrictions except for peak hours.

2.a.

NHDP's prime focus is on developing International standard roads with facilities for uninterrupted flow of traffic with :

- • Enhanced Safety Features • Better Riding Surface. • Better Road Geometry • Better Traffic Management and Noticeable Signage. • Divided Carriageways and Service Roads • Grade Separators • Over Bridges and Underpasses • Bypasses • Wayside Amenities

- The Government of India has launched major initiatives to upgrade and strengthen National Highways through seven phases of National Highways Development Project (NHDP), the main components of NHDP are:
- NHDP Phase I and II Comprises of the development of National Highways to 4/6 lane standards of the following routes; (a) Golden Quadrilateral (GQ) connecting 4 major metropolitan cities viz. Delhi-Mumbai-Chennai-Kolkata-Delhi (b) North South and East West Corridors (NS-EW) connecting Srinagar to Kanyakumari and Silchar to Porbandar with a spur from Salem to Cochin. (c) Road connectivity of major ports of the country to National Highways. (d) Other National Highway stretches
- NHDP Phase-III The Government has approved 4/6 laning of 12,109 km of National Highways on Build, Operate and Transfer (BOT) basis at an estimated cost of Rs.80,626 crore under NHDP-III. The phase has been approved in two parts i.e. Phase-III A consisting total length of 4,815 km at an approved cost of Rs.33,069 crore and Phase-III B, consisting total length of 7,294 km at an approved cost of Rs.47,557 crore.

KSHIP

It is an initiative of Government of Karnataka for the improvement of road network of the state with World Bank assistance.

- PWD carried out Strategic Option Study (SOS) during 1996 on a road network of 13,362 Km comprising SH and MDRs and the study identified 2888 Km of road for prioritized improvements.
- The main objectives are: 1. Upgrade about 615 Km of SH in Karnataka and strengthen capacity of PWD of Government of Karnataka to develop, upgrade and maintain state road network.

2. Improve core road network in Karnataka. Core road includes SH and heavy traffic MDRs.

3. Improving existing road network involving rising of formation levels, strengthening of pavements, widening and realignment of roads wherever necessary.

4. Enhance capacity and quality of core SH network, provide safer transit on selected corridors, improve allocation and provide adequate funding for road sector, provide more efficient and effective network management.

2.b.

1) Population served by the road network

2) Productivity (industrial and agricultural) served by the road network.

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:
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.

3.a.

Proposal	Total road length (Km)	No: of town & villages served with population range				Total units		Utility per unit length	Priority based on utility
		1001-2000	2001-5000	5001-10000	>10,000	Population	Productivity		
P	300	160*0.25 = **40**	80*0.5= **40**	30*1.0 = **30**	6*2.5 = **15**	40+40+30+15 = **125**	**200**	$\frac{325}{300} = \mathbf{1.083}$	**II**
Q	400	200*0.25 = **50**	90*0.5 = **45**	60*1.0 = **60**	8*2.5 = **20**	50+45+60+20 = **175**	**270**	$\frac{445}{400} = \mathbf{1.112}$	**I**
R	500	240*0.25 = **60**	110*0.5 = **55**	70*1.0 = **70**	10*2.5 = **25**	60+55+70+25= **210**	**315**	$\frac{525}{500} = \mathbf{1.050}$	**III**
S	550	248*0.25 = **62**	112*0.5 = **56**	73*1.0 = **73**	12*2.5 = **30**	62+56+73+30 = **221**	**335**	$\frac{556}{550} = \mathbf{1.010}$	**IV**

3.b.

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.

4.a.

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 survey the given steps:

1) *Primary survey*
2) *Topographical features*
3) *Levelling work*
4) *Drainage studies*

5) *Soil survey*
6) *Material survey*
7) *Traffic survey*

4.b.

- ✓ 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.
- ✓ During the reconnaissance, the engineer visits the site and examines the general characteristics of the area before deciding the most feasible routes for detailed studies
- ✓ Simple instruments are used. Abney level, Barometer, Tangent clinometer etc.

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.

5.a.

1) ***Map study***:- Using the available topographic map of India.
2) ***Reconaissance survey:-*** A general idea of topography, soil survey and material survey by on the spot inspection of the site
3) ***Preliminary survey:-*** Topographic details& soil survey along alternate alignments, consideration of geometric design, preparation of plans, comparison of various routes, economic analysis and final alignment selection.

4) ***Location of final alignments***:- Transfer of alignments from drawings to ground, setting out geometric design elements by location of circular and transition curves, tangent & apex points, super elevation details etc.
5) ***Detailed survey:-*** Survey of highway construction work for preparing longitudinal & cross sections, earthwork, quantity determination, checking details of geometric design elements.
6) ***Materials survey:-*** Survey of construction materials, their collection and testing.
7) ***Design:-*** Design details of embankment and cut slopes, foundation of embankments& bridges etc.
8) ***Earthwork:-*** Excavations for highway cutting & drainage system, embankment construction.
9) ***Pavement construction:-*** Preparation of subgrade, construction of sub-base& surface courses.
10) ***Construction controls:-*** Quantity control tests at different stages of construction & check for finished road surface such as unevenness, camber, super elevation etc.

5.b.

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

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

1) 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 Alignment Should Pass

a) **Bridge site**: The bridge can be located only where the river has **straight and permanent** path. It should not be curved and skew crossing should be avoided as possible.
b) **Mountain:** While the alignment passes through a mountain, the various alternatives are to either construct a tunnel or to go around the hills.

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.

2)Traffic: -

- The alignment should suit the traffic requirements.
- The origin- destination data of the area, the desire lines should be drawn.

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.