TRANSPORTATION ENGINEERING - I

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A Hand-note On

TRANSPORTATION ENGINEERING - I

CE 351

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Topics

Importance
Highway materials
Highway alignment
Highway geometric design
Traffic engineering
Road accident

Problems

Importance of Transportation Engineering

CE-351

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Q-1: What do you mean by transportation engineering?

Transportation Engineering:

Transportational engineering deals with the transhipment of persons and goods from one place to another by any shorts of vehicles.

For rapid economical, industrial, social and cultural development of any country, a good system of transportation in very essential.

A good system of transportation include a good network of highways, railways, waterways and airways. As blood transportation through arteries in essential for well being of the human being similarly good system of transportation in essential for well being of nation.

09
Q-2: Discuss what important roles played by transport?

Important roles played by transport:

i) It given "place utility" to goods.

ii) It brizen the space gap between the consumer and the producers.

iii) It given time utility.

iv) Facilitates the ~~expolar~~ explorcation(उत्खनन) of natural resources.

v) Facilitates international trade and commerce

vi) It is important for the defence of a country

vii) Enables the governance of vast area after the control of a nation

viii) The pattern of growth of towns and cities is determined by the transportation network.

ix) Transport is a promoter of tourism.

x) It helps in fighting natural calamities like floods, cyclones, drought (अनावृष्टि) and famine.

Short note:

04

Economic activity & transportation:

It may be said that the increased productivity and in efficient transportation can lower the cost of product.

05 04

Social effects & transportation:

Population have always settle along the rivers shores, road sides and near the railway station. Attempts are made to decentralize the population centres away from the sides of main transportation routes.

Rural development & transportation:

About 75% of the population of the country living in the villages, the development in urban centres alone do not indicate the overall development of the country. Only with the improvement in transportation facilities in rural areas, there would be faster development.

10,09,08,04,03

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Q-3: What are the modes of transportation?

Different modes of transportation:

i) Highways
ii) Railways
iii) Water ways
iv) Air ways
v) Rope ways
vi) Belt conveyors
vii) Pipe lines
viii) Cable cars
ix) Mono-rail

10,09,07,06,05

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Q-4: Briefly discuss the characteristics of road transportation.

Characteristics of road transportation:

i) Road transport is the nearest to the people which give maximum service to one and all.

ii) Roads are used by various types of road vehicles.

iii) Road transport requires a relatively small investment.

iv) Complete freedom to transfer the vehicle from one lane to another.

v) For short distance travel, road transport saves time.

vi) It offers itself to the whole community.

vii) Speed of movement is directly related with the severity (violence) of accident.

10,09,08,07,06,05,03

Q-5: Explain the necessity and objects of highway planning.

Necessity of highway planning:

In the present era planning is consider as a pre-requisite before attempting any development program, especially for any engineering work. Planning is of great importance when the funds available are limited whereas the total requirement is much higher.

Objectives of highway planning:

i) To plan a road network for efficient and safe traffic operation with minimum cost.

ii) To select road system with maximum utility and can be constructed within the available resources during the plan period.

iii) To fix up determine priorities for development of each road link based on utility.

iv) To plan for future requirements and improvements of road.

v) To work out financing system.

Q-6: Clasify the road based on function and location.

Classification of roads:

Based on location and function —

i) National Highways (NH)

ii) State Highways (SH)

iii) Major District Roads (MDR)

iv) Other District Roads (ODR)

v) Village Roads (VR)

Q-7: Discuss about road transport in Bangladesh.

ROAD TRANSPORT IN BANGLADESH:

i) Significance of planned network:

a) Overall economic progress can be achived.

b) Generates considerable employment.

c) Good pavement conditions saves operating cost 15 to 40%.

ii) Requirement of rural road development:

There are 68 thousands villages in Bangladesh. Only about 20% villages are connected with paved road. LGED is actively engaged in the development of rural road.

ii) Comparative study of road statistics:

The poor state condition of road development in Bangladesh in the past may be due to the following reasons –

a) There are no planned development of roads.

b) Investment on road development is much lower.

c) Poor economic conditions of the vast majority of the population in the villages.

Q-7: "As blood circulation through body arteries is essential for well being of a human being, similarly a good systems of transportation is essential for well being of nation" - Justify this statement.

Answer:

For rapid economic, industrial and cultural growth of any country, a good system of transportation is very essential. Transportation system comprises of good network of roads, railways, well developed water ways and airways. Airways and water ways although help to some extent in transportation within the country, but they are the modes of transport mainly with foreign countries. Railways and highways, also to some extent help in transport with foreign countries but their main concern is within the country itself.

An industrialist has to transport the raw materials and then market his finished products. He can do so efficiently only through a good system of transportation. In big metropolitan

cities, reaching the working places requires a good system of transportation, which may be in the form of urban railway system or bus system. A farmers can market his agricultural produce to the nearby market economically only through a good system of roads. So, development of any country could not be possible without a good system of transportation. Therefore we can say that, " As blood circulation through body arteries is essential for well being of a human being, similarly a good system of transportation is essential for well being of a nation".

Q : Discuss about highway planning survey.

Highway planning survey:

For the assessment of required road length. field surveys are to be carried out to collect the data. This field survey is called highway planning survey.

The planning surveys consist of the following studies:

i) Economic studies
ii) Financial "
iii) Traffic or road use studies
iv) Engineering studies

I) Economic studies:

a) Population, its distribution and classification
b) Trend of population growth
c) Listing of agricultural and industrial development

PTL

ii) Financial studies:

a) Sources of income
b) Revenue from taxation on road transport
c) Living standards.

SEL

iii) Traffic or road use studies:

a) Traffic volume
b) Traffic flow patterns
c) Accidents
d) Growth of vehicle and traffic

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iv) Engineering studies:

a) Road location and alignment studies.

b) Types of roads in use.

c) Maintenance problems.

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Q- : Draw the various road patterns commonly in use.

i) Rectangular or block pattern

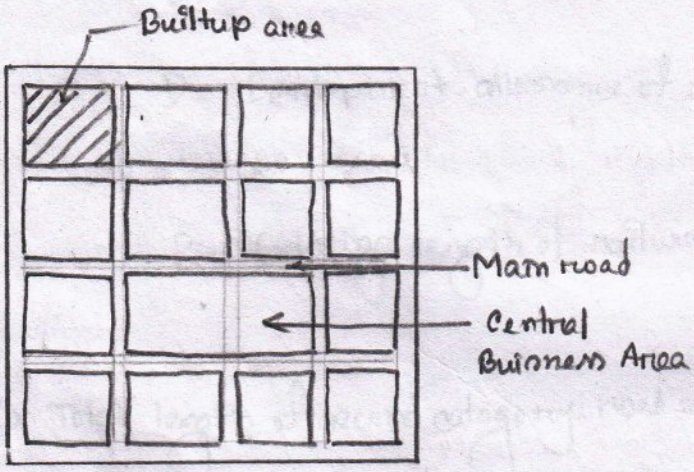
ii) Radial or star and block pattern

iii) Radial or star and circular pattern

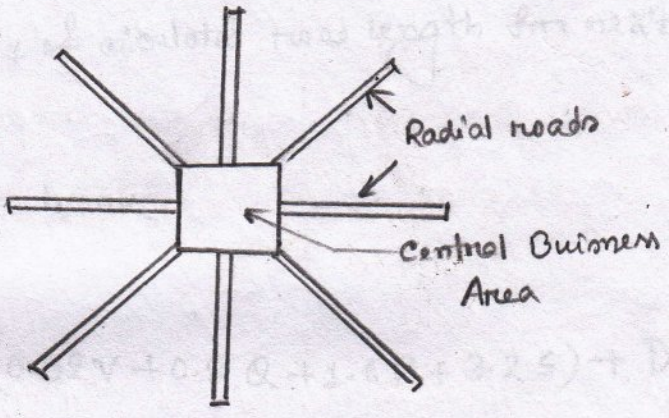
iv) Radial or star and grid pattern

v) Hexagonal pattern

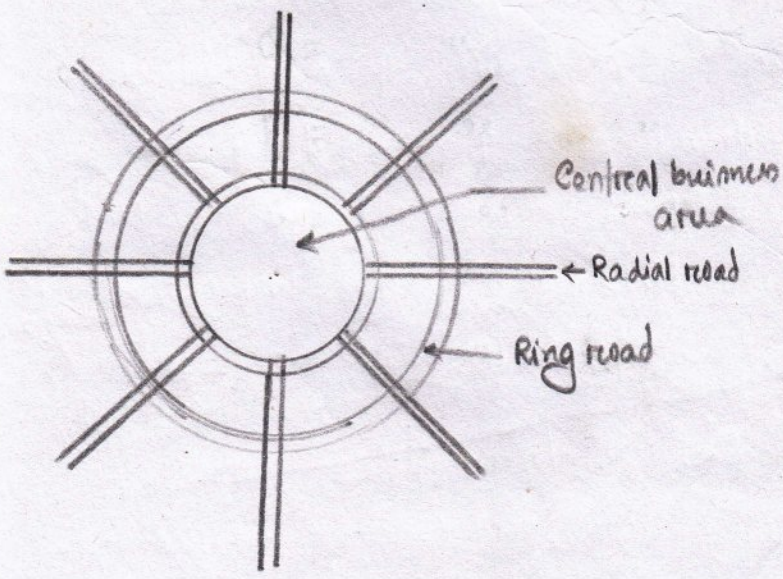
vi) Minimum travel pattern



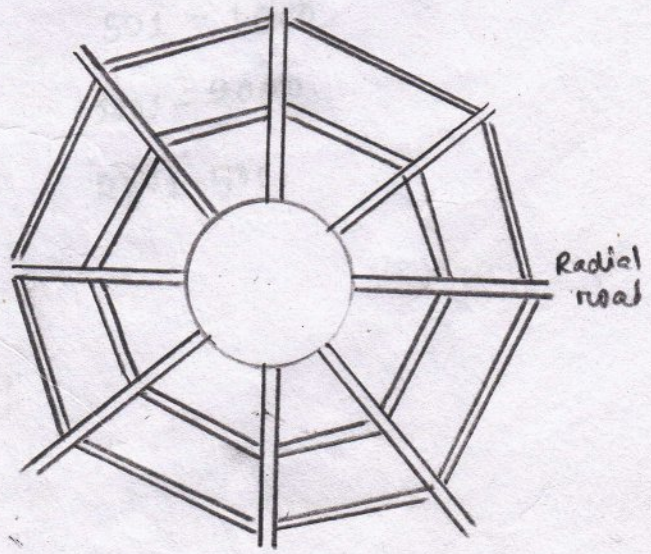
i) Rectangular or block pattern



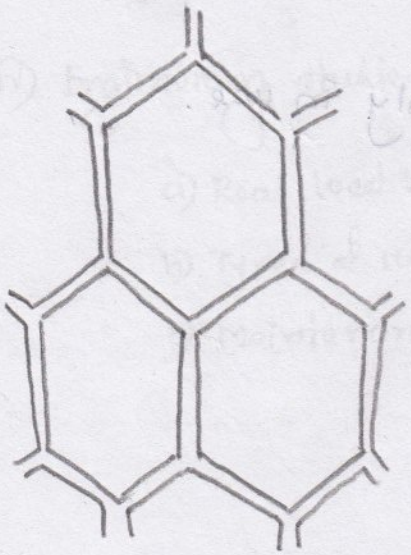
ii) Radial or star and block pattern



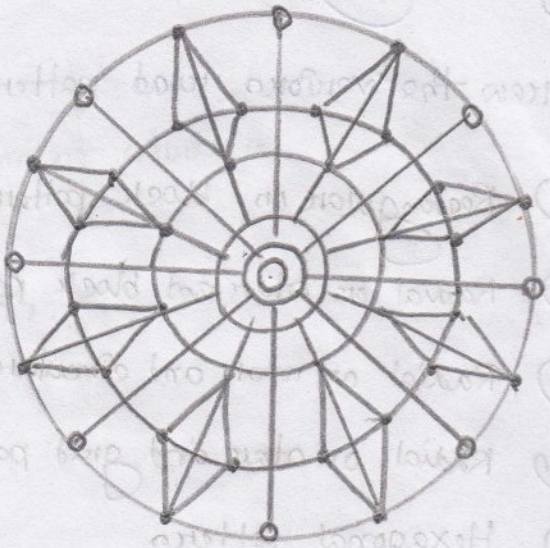
iii) Radial or star and circular pattern



iv) Radial or star and grid pattern



v) Hexagon pattern



vi) Minimum travel pattern

(A+)

Total length of the metalled roads in km is given by the formula:

$$\text{Total length} = \left(\frac{A}{8} + \frac{B}{32} + 1.6N + 8T\right) + D - R$$

where,

A = Agricultural area, km^2

B = Non-agricultural area, km^2

N = Number of towns and villages with population range 2001-5000

T = " " " " " over 5000

D = Development allowance of 15% of calculated road length for next 20 years

R = Existing length of railway track

⇒ Total length of second category road = $(0.32V + 0.8Q + 1.6P + 3.2S) + D$

where,

V = Number of villages with population 500 or less

Q = " " " 501 - 1000

P = " " " 1001 - 2000

S = " " " 2001 - 5000

CE-06

Problem-01: Calculate the additional length of metalled and unmetalled roa from the following data:

i) Total area = 9600 km²

ii) Agricultureal area = 3200 km²

iii) Existing railway length = 105 km

iv) Existing length of metalled road = 322 km

v) " " of unmetalled " = 450 km

vi) Number of towns and villages in different population ranges given in table below:

Population	>5000	2001-5000	1001-2000	501-1000	<500
No of towns and villages	8	40	130	280	590

Solution:

$A = 3200\ km^2$ $B = 9600 - 3200 = 6400\ km^2$ $N = 40$

$T = 8$ $R = 105\ km$

$$\text{Total length} = \left(\frac{A}{8} + \frac{B}{32} + 1.6N + 8T\right) + D - R$$

$$= \left(\frac{3200}{8} + \frac{6400}{32} + 1.6 \times 40 + 8 \times 8\right) + 15 \times \frac{728}{100} - 105$$

$$= 728 + 109.2 - 105$$

$$= 732.2\ km$$

$\therefore$ Additional length $= 732.2 - 322 = 410.2\ km$

Total length of second catagory road $= (0.32V + 0.8Q + 1.6P + 3.2S) + D$

$= (0.32 \times 590 + 0.8 * 280 + 1.6 \times 130 + 3.2 \times 40) + 15 \times \frac{748.8}{100}$

$= 748.8 + 112.32$

$= 861.12$ km

∴ Additional length $= 861.12 - 450 = 411.12$ km. (Ans).

CE-10

Problem-02 : Calculate the additional length of metalled and unmetalled road from the following data:

i) Total area = 25000 km², ii) Agricultural and developed area = 7200 km², iii) Existing metalled road = 700 km iv) Existing unmetalled road = 1100 km v) Length of railway = 200km vi) Number of towns and villages are as:

Population range :	>5000	2000-5000	1000-2000	500-1000	<500
No of towns and villages :	14	85	250	500	1300

Solution:

Total length $= \left(\frac{A}{8} + \frac{B}{32} + 1.16N + 8T\right) + D - R$

$= \left(\frac{7200}{8} + \frac{17800}{32} + 1.16 \times 85 + 8 \times 14\right) + 15 \times \frac{1704.25}{100} - 200$

$= 1704.25$
~~1666.85~~ + ~~250.03~~ 255.65 − 200

= ~~1716.88 km~~ 1760.90 km

∴ Additional length of metalled road = 1760.90 − 700 = ~~1016.88 km~~ = 1060.90 km

Total length $= (0.32V + 0.8Q + 1.6P + 3.2S) + D$

$= (0.32 \times 1300 + 0.8 \times 500 + 1.6 \times 250 + 3.2 \times 85) + 15 \times \frac{1488}{100}$

$= 1488 + 223.2$

$= 1711.2$ km. (Ans

∴ Additional length $= 1711.2 - 1100 = 611.2$ km. (Ans).

08,01,99

Q: "The development of Bangladesh is dependent on the development of its transportation system" Justify the statement.

Answer:

Bangladesh is a country of villages. More than 75% of its population is dependent on agriculture. If economic condition of our villages is improved, it will reflect improvement in over-all economy of the country. The basis of economy of our country is agriculture. If we suffer in agricultural field, our economy is bound to suffer.

The most demanding fact that for our country is that proper road links should be established between villages and markets. With better transport facilities, farmers can get better market values for their products. Similarly education will also reach remotest regions and help remove illeteracy from the country.

Industry and agriculture are interdependent sectors to some extent. Industries require raw material from villages for their finished products and thus have better chances of success if they are set nearer the fields.

The roads play vital role in the defence of the country. It is said that doctors do not want to go to villages. This fact can be attributed to lack of good system of transportation to some extent.

In short it can be said that for the over-all development in our country - good system of transportation is a pre-requisition.

08

Problem-03: Calculate the additional length of metalled road for the following data:

(i) Total area = 9000 sq. km (ii) Agricultural area = 3000 sq. km

(iii) existing railway = 100 km (iv) existing metal road = 300 km

Population	>5000	2000-5000	1001-2000	501-1000	< 500
No of towns and villages	8	40	130	280	590

Solution:

Here, $A = 3000$ sq. km $\quad B = 9000 - 3000 = 6000$ sq-km

$R = 100$ km $\quad N = 40 \quad T = 8$

$$\text{Total length} = \left(\frac{A}{8} + \frac{B}{32} + 1.6N + 8T\right) + D - R$$

$$= \left(\frac{3000}{8} + \frac{6000}{32} + 1.6 \times 40 + 8 \times 8\right) + 15 \times \frac{690.5}{100} - 100$$

$$= 690.5 + 3.58$$

$$= 694.08 \text{ km}$$

$\therefore$ Additional length of metalled road $= 694.08 - 300$

$= 394.08$ km.

(Ans).

06

Highway Materials

Q. Define subgrade soil.

Subgrade soil:

Subgrade soil is the natural soil used for the preparation of foundation layer of road to receive the other layers of the road. Therefore, this layer should possesses sufficient strength and stability under adverse climatic and loading conditions. Pavement defects such as the formation of corners, corrugating, rutting, cracking in pavement are developed due to poor subgrade.

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Q. What are the desirable properties of subgrade soil.

Desirable properties of subgrade soil:

i) Stability
ii) Incompressibility
iii) Permanancy of strength
iv) Minimum volume change
v) Good drainage
vi) Ease of compaction

SIP MGE

03,04,08

Q. what are the desirable properties of aggregate as a highway material.

Desirable properties of aggregate:

i) Strength:
Resistance to compressive load. Aggregate should be strong enough to withstand the stressses due to traffic loads.

ii) Hardness:
Resistance to abrasion forces. Aggregate should be strong enough to resist the wears due to abrasive action of traffic.

iii) Toughness:
Resistance to impact. Aggregates should have sufficient toughness.

iv) Durability:
Resistance to adverse action of weather. Aggregates should be durable and capable of resisting adverse weathing action.

v) Shape:
Aggregates may have rounded, cubical, angular, flaky or elongated in shape. Angular aggregates should be choosed.

vi) Cementation and adhesion:
Aggregates should have good cementing and adhesive property to make strong bond with cement or bitumen.

07, 09

Q. Why angular shape aggregates are suitable for road construction?

The rounded aggregate particles have less interlocking property but in case of angular shaped aggregates, they possess high interlocking characteristics which is a useful property in WBM and bituminous road construction.

That is why angular aggregates are suitable for road construction.

CE-351

Highway Alignment

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Q-1: What do you mean by alignment.

Alignment:

The position on the layout of the centre line of the highway on the ground is called the alignment.

The horizontal alignment includes the straight path, the horizontal deviations and curves. Changes in gradient and vertical curves are covered under vertical alignment of roads.

Q-2: What are the disadvantages of improper alignment.

Disadvantages of improper alignment:

A new road should be aligned very carefully as improper alignment would result in one or more of the following disadvantages:

i) increase in construction cost
ii) increase in maintenance cost
iii) increase in vehicle operation cost
iv) increase in accident rate

09

Q-3: What are the basic requirements of an ideal alignment? Discuss briefly.

Requirements of an ideal alignment:

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

i) Short
ii) easy
iii) safe, and
iv) economical

i) Short:

A straight alignment would be the shortest, though there may be several practical considerations which would cause deviations from the shortest path.

ii) Easy:

The alignment should be such that it is easy to construct and maintain the road with minimum problems.

iii) Safe:

The alignment should be safe enough for construction and maintenance from the view point of stability of natural hill slopes, embankments and cut slopes and foundation of embankments.

iv) Economical:

The road alignment could be considered economical only if the total cost including initial cost, maintenance cost and vehicle operation cost is lowest.

09

Q-4: Explain with sketches various factors controlling the alignment of roads.

Factors controlling alignment:

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

i) Obligatory points
ii) Traffic
iii) Geometric design
iv) Economics
v) Other considerations

OTGEO

In hill roads additional care has to be given for: Stability, Drainage, Geometric standards of hill roads and Resisting length.

i) **Obligatory points:** There are control points governing the alignment of the highways. These control panel may be divided broadly into two categories:

a) Points through which the alignment is to pass
b) Points through which the alignment should not pass.

a) Obligatory points through which the road alignment has to pass may cause the alignment to often deviate from the shortest or easiest path. The various examples of this category may be bridge site, intermediate town, a mountain pass or a quarry (পাথরের খাদ)

b) Obligatory points through which the road should not pass also may ~~ken~~ 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, unsuitable land etc.

ii) **Traffic:**

The alignment should suit traffic requirements. The new road to be aligned should keep in view the desired lines, traffic flow patterns and future trends.

iii) **Geometric design:**

Geometric design factors such as gradients, radius of curve and ~~straight~~ 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.

iv) **Economy:**

The alignment finalised 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.

v) **Other consideration:**

Various other factors which may govern the alignment are drainage considerations, hydrological factors, political considerations and monotony. (একঘেয়েমি)

08

Q- : Discuss different stages of the engineering surveys?

Engineering surveys for highway locations:

The stages of the engineering surveys are –

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

MRPF

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Q. -: What are the drawings prepared in a highway project?

The following drawings are usually prepared in a highway project:

i) Key map
ii) Index map
iii) Preliminary survey plans
iv) Detailed plan and longitudinal section
v) Detailed cross-section
vi) Land acquisition plans
vii) Drawings of cross drainage and other retaining structures
viii) Drawings of road intersections
ix) Land plans showing quarries etc.

DDDDIKLLP

Q- : Discuss about special considerations while aligning road on hilly area.

Special considerations while aligning roads on hilly areas:

Stability:

While aligning hill roads, special care should be taken to align the road along the side of the hill which is stable. The cutting and filling of earth to construct roads on hill-side causes steepening of existing slopes and affect its stability.

Drainage:

Numerous hill-side drains should be provided for adequate drainage facility across the road. But the cross drainage structure being costly, attempts should be made to align the road in such a way where the number of cross drainage structures are minimum.

Geometric standard of hill roads:

Different sets of geometric standards are followed in hill roads with reference to gradient, curves and speed and they consequently influence the sight distance, radius of curve and other related features.

Resisting length:

The resisting length of a road may be calculated from the total work to be done to move the loads along the route taking the horizontal length, the actual difference in levels between the two

stations and the sum of ineffective rise and fall in excess of floating gradient.

Q. Discuss about project report.

Project report:

It should contain information such as -

i) General details of the projects and its importance.

ii) Feature of the road including selection of the route, alignment, traffic etc.

iii) Road design and specifications

iv) Drainage facilities and cross drainage structures.

v) Materials, labour and equipment.

vi) Rates

vii) Construction programming

viii) Other miscellaneous items like diversion roads, traffic control, road side amenities, rest houses etc.

miscellaneous - বিবিধ

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05,07,10

Q: Discuss about different steps in a new highway project.

New highway project:

The new highway project work may be divided into the following stages:

i) Selection of route, finalisation of highway alignment and geometric design details.

ii) Collection of materials and testing of subgrade soil and other construction materials mix design of pavement materials and design details of pavement layers.

iii) Construction stages including quality control.

Q: What are the necessity of re-alignment.

Necessity of re-alignment:

i) Improvement of horizontal alignment design elements.

ii) Improvement of vertical alignment design elements like steep gradients, changes in summit curves to increase sight distance.

iii) Realignment required due to a portion of the road being submerged under water.

iv) construction of a bypass to avoid the road running through a town or city.

v) Defence requirements.

Q. How can you prepare drawing for re-alignment project.

Preparation of drawings for re-alignment project:

i) Plan showing existing road, proposed alignment, contours and all other features of importance.

ii) Longitudinal section showing natural ground elevation, surface of the existing road and the grade line for the re-construction.

iii) Cross section showing the existing roadway and new roadway drawn at 250m intervals on straights, at the beginning and end of transition curves and at the middle of circular curves. Cross-sections are drawn at 50m interval where the new carriageway falls entirely outside the existing one.

Steps of new-highway project:

i) Map study
ii) ~~Recon~~ Reconnaissance
iii) Preliminary survey
iv) Location of final alignment
v) Detailed survey
vi) Material survey
vii) Design
viii) Earth work
ix) Pavement construction
x) construction control

CE-351

Highway Geometric Design

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Q. What are the importance of geometric design.

i) The geometric design of highway should be design to provide optimum efficiency in traffic operation with maximum safety at reasonable cost.

ii) It is important to plan and design the geometric features of the road during the initial alignment itself taking into consideration the future growth of traffic flow and possibility of the road being upgraded to a higher category.

Q. What are the elements of geometric design of highway.

Geometric design of highway deals with the following elements:

i) Cross section elements
ii) Sight distance consideration
iii) Horizontal alignment details
iv) Vertical alignment details
v) Intersection elements

CSHVI

090063

Q. Write short notes on:

07,08 i) Skid 10, ii) Slip 08.07.06.04 iii) Carriage way 07 iv) Camber

i) Skid : (S-120)

Wheel slide without revolving, is known as skidding. In skidding phenomenon the distance travelled by wheel on road is greater than the circumferential movement of the wheel. When breaks are applied wheels get locked and still if vehicle moves ahead longitudinal skidding takes place.

ii) Slip : (S-121)

In slip, distance travelled by wheel on road surface is always less than the circumferential movement of the wheel. In sands rear driving wheels generally slip. On wet road surfaces, slip may also take place.

iii) Carriage way : (S-127)

Metalled pucca strip of road meant for vehicular traffic movement, is called carriage way. Width of carriage way depends on the width of the traffic lane and number of traffic lanes.

iv) Camber : (S-123)

Transverse slope given to the road surface is called camber. It is sometime also called cross-slope. It is provided mainly to drain off rain water from the road surface. It is denoted by 1 in n.

Amount of camber mainly depends on two following factors:

i) Amount of rainfall and
ii) Type of road surface.

v) Crown : (S-123)

In straight roads the central heighest point is called the crown.

vi) Friction : (S-119)

Friction between vehicles tyres and road surface is one of the factors determining the maximum operating speed and distance requirements for stopping and accelerating the vehicles.

vii) Pavement smoothness or unevenness : (S-122)

Smooth and even road pavements permit higher operating speeds. Pavement surface should be constructed and maintained as even as possible so that minimum design

speed may be maintained on it.

Unevenness of road surface is measured by unevenness index. Unevenness index is the cumulative sum of vertical undulations in road surface per unit horizontal length of the road and is measured in cm/km.

Q. What are the reflecting characteristics of road pavement.

Reflecting characteristics of road pavement: (S-123)

Colour of the road surface affects visibility conditions. Light brown coloured surfaces although give good visibility at night, but produce glare and put lot of strain on drivers eyes during bright sun. On the other hand, bitumen surfaces provide poor visibility at night especially when surface is wet, but do not produce glare in bright sun.

glare → চোখ ঝলসানো আলোক

Q. Why excessive camber should not be provided. (S-123)

Excessive camber should not be provided unnecessarily because of the following reasons:

i) Most of the vehicles will tend to move along the centre line of the road and thus road capacity is affected.

ii) Because of tilt (কাত হওয়া), high loaded vehicles may topple (উল্টে পড়া) over easily.

iii) Due to rapid flow of rain water, cross-cuts may develop on the road surface.

iv) During overtaking operation, vehicles tend to drag (টেনে নেয়া), causing uncomfortable conditions.

v) Three types of chambers are in use. They are parabolic or elliptical, straight sloped and composite cambers.

Q1. Write short note on : Providing camber

Providing Camber :

To provide desired amount and shape of the camber, wooden camber boards or templets are prepared. In case of parabolic camber boards, following equation should be used to determine the offsets from the horizontal line drawn through the crown.

$$y = \frac{2x^2}{nB}$$

Where, B = Width of pavement

n = camber (for 1 in 20 camber, value of n is 20)

x = horizontal distance of the point where offset or ordinate is being determined from the centre of the pavement

y = offset or ordinate of wooden boards

At centre value of y is zero.

Problem-01: The bituminous road has 3.8m wide carriage way. Calculate height of crown above the edges. Provide camber 1 in 48.

Solution:

Height of centre point above edges

$$= \frac{3.8}{2} \times \frac{1}{48}$$

$$= \frac{3.8}{2} \times \frac{100}{48}$$

$$= 3.96\text{cm}$$

$$\simeq 4\text{cm.} \quad (\text{Ans}).$$

03, 04, 06, 07, 08

Q. Write short note on width of pavement or carriage way.

Width of pavement or carriage way:

Metalled pucca strip of road used for vehicular traffic movement is called carriage way. Width of carriageway depends on the width of traffic lane and number of traffic lanes.

Q. Draw the lateral placement of vehicles.

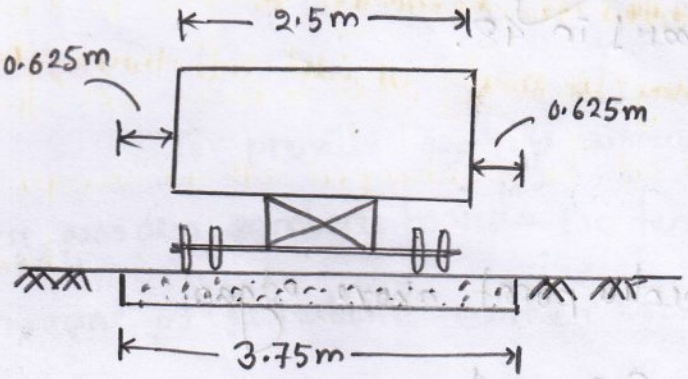


Fig: Single lane pavement

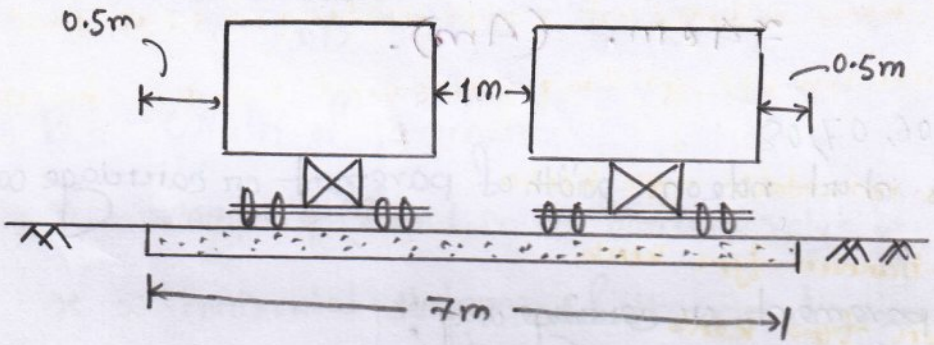


Fig: Two lane pavement

Q. Define kerb, Road margin, Right of way, Shoulder.

Kerb:

Kerb indicates the boundary between the pavement and shoulder. Kerb may be mainly divided into three groups based on their functions.

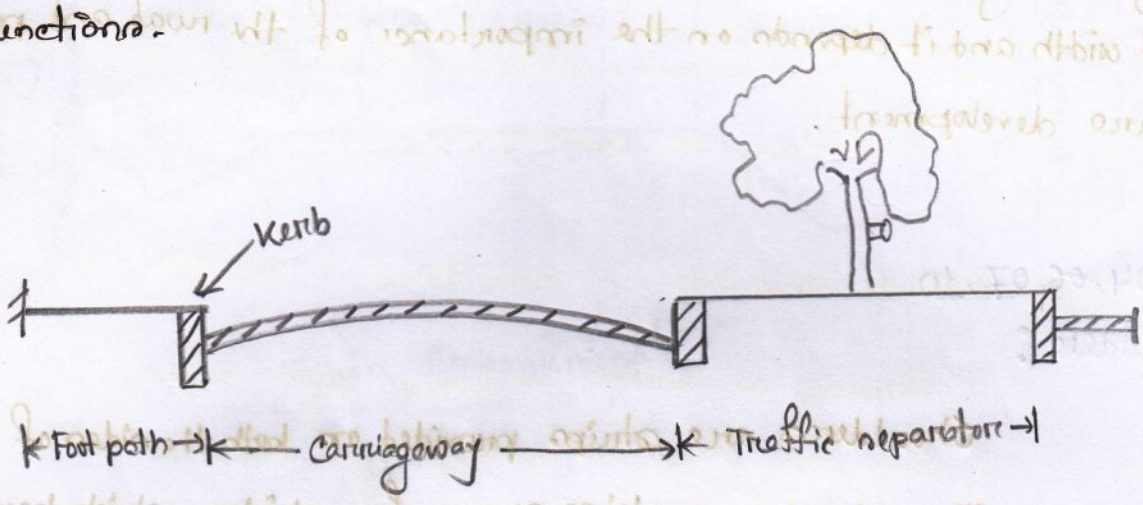


Fig: kerb and traffic separator

i) Low or mountable type kerbs
ii) Semi-barrier type kerb
iii) Barrier type kerb

In rural roads submerged kerbs are sometimes provided.

00

Road margin:

The various elements such as shoulder, parking lane, frontage road, driveway, cycle track, footpath, guard rail and embankment slope are combinedly known as road margins.

090063

Q. 03, 04, 05, 06

Right of way:

acquired

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.

03, 04, 06, 07, 10

Shoulder:

Shoulders are strips provided on both the sides of the carriageway. They serve as parking space for vehicles which have developed some defect and need temporary parking. Its minimum width is 1m.

03, 05

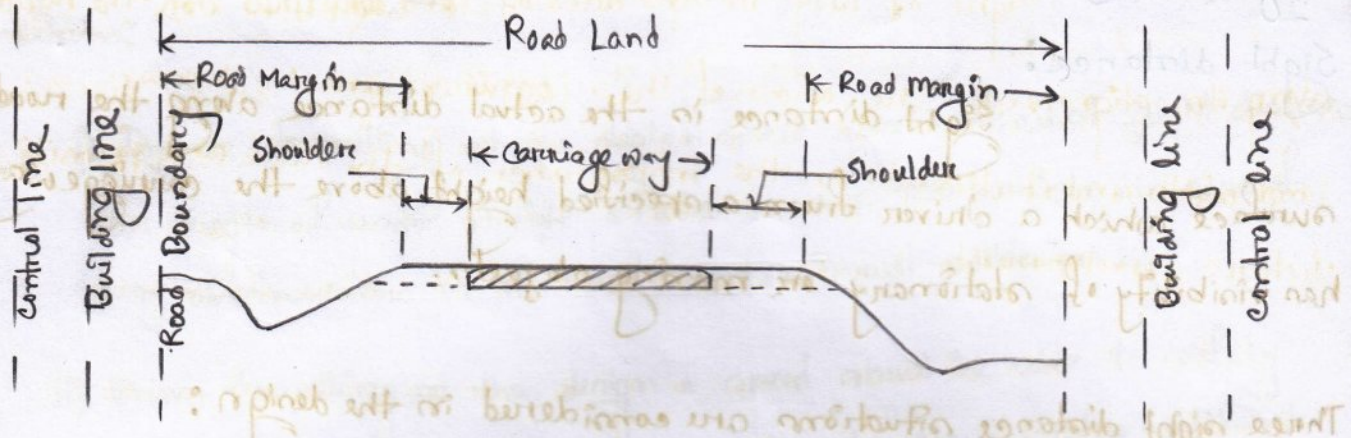
Traffic separator:

Traffic separators are the indicators for separating traffic comming from opposite direction. Separators may be in the form of road marking by white lines, concrete or masonry dividers or area separators.

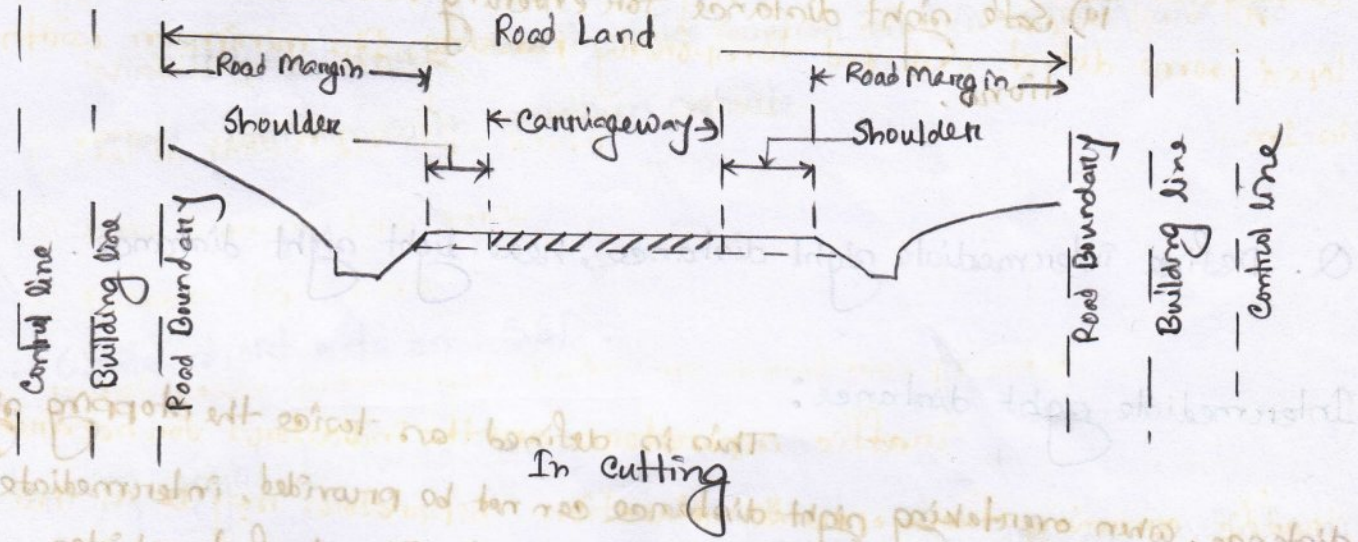
Width of roadway or formation:

Width of formation or roadway is the sum of widths of pavements or carriageway including separators if any and the shoulders.

Q. Draw the cross section details of roads in embankment and cutting.



In Embankment



In Cutting

Sight Distance

AHSAN
090063

Q. Define sight distance.

10

Sight distance:

Sight distance is the actual distance along the road surface which a driver from a specified height above the carriageway has visibility of stationary or moving objects.

Three sight distance situations are considered in the design:

i) Stopping or absolute minimum sight distance
ii) Safe overtaking or passing sight distance
iii) Safe sight distance for entering into uncontrolled intersections.

Q. Define intermediate sight distance, head light sight distance.

Intermediate sight distance:

This is defined as twice the stopping sight distance. When overtaking sight distance can not be provided, intermediate sight is provided to give limited overtaking opertunities to fast vehicles.

Head light sight distance:

This is the distance visible to a driver during night driving under the illumination (আলোকিতকরণ) of the vehicle head lights.

2. What are the conditions for sight distance.

The standards for sight distance should satisfy the following three conditions:

i) Driver travelling at the design speed has sufficient sight distance or length of road visible ahead to stop the vehicle, in case of any obstruction on the road ahead, without collision.

ii) Driver traveling at the design speed should be able to safely overtake, at reasonable intervals, the slower vehicles without causing obstruction or hazard to traffic of opposite direction.

iii) Driver entering an uncontrolled intersection has sufficient visibility to enable him to take control of his vehicle and to avoid collision with another vehicle.

Q. Write short note on SSD.

Stopping Sight Distance (SSD):

The minimum sight distance available on a highway at any spot should be of sufficient length to stop a vehicle travelling at design speed, safely without collision with any other obstruction.

10

SSD depends on:

a) Total reaction time of the driver
b) Speed of vehicle
c) Efficiency of brakes

d) frictional resistance between the road and the tyres

e) Gradient of the road.

05

Q. Define total reaction time.

Total reaction time:

Reaction time of the driver is the time taken from the instant the object is visible to the driver to the instant the brakes are effectively applied.

The total reaction time may be split up into two parts:

i) Perception time

ii) Brake reaction time

i) Perception time:

The perception time is the time required for a driver to realise that brakes must be applied.

ii) Brake reaction time:

The brake reaction time also depends on several factors including the skill of the drivers, the type of the problems and various other environmental factors.

Q. Discuss PIEV theory.

PIEV Theory:

According to this theory the total reaction time of the driver is split into four parts.

i) Perception
ii) Intellection
iii) Emotion
iv) Volition

i) Perception:

Perception time is the time required for the sensations received by the eyes or ears to be transmitted to the brain through the nervous system and spinal chord.

ii) Intellection:

Intellection time is time required for understanding the situation.

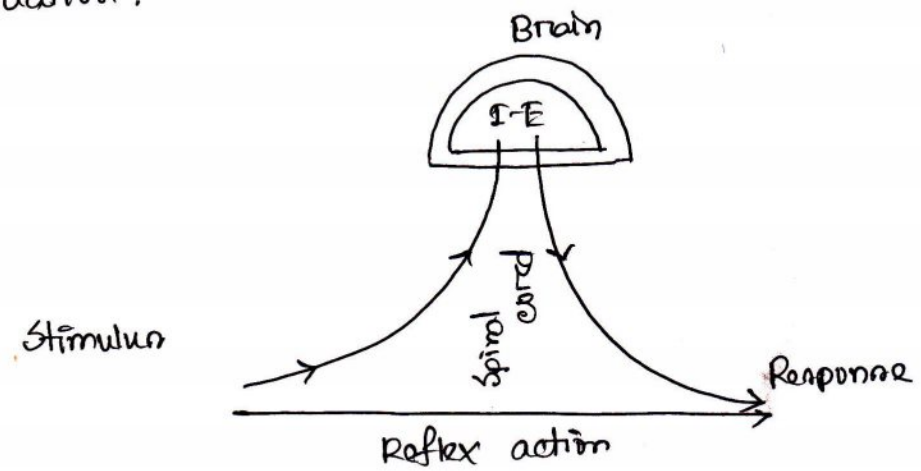


fig: Reaction time and PIEV process

iii) Emotion: Emotion time is the time elapsed during emotional sensations and

disturbance such as fear, anger or any other emotional feelings such as p
sation etc.

iv) Volition:

Volition time is the time taken for the final action.

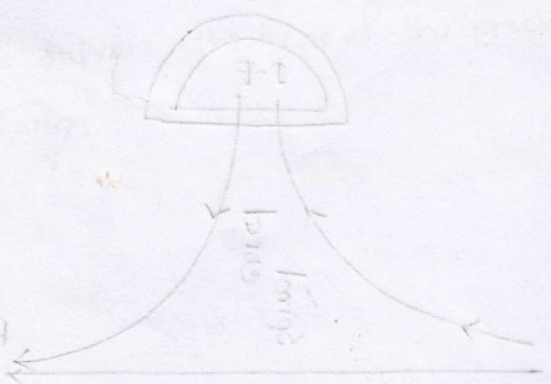
Q. Define lag distance and breaking distance.

Lag distance:

The distance travelled by the vehicle during the total reaction time known as lag distance.

Breaking distance:

The distance travelled by the vehicle after the application of the braker, to a dead stop position which is known as the breaking distance.



05

Q. Derive an expression for finding SSD at level.

If 'v' is the design speed in m/sec and 't' is the total reaction time of the driver in seconds, then

$$\text{Lag distance} = vt$$

If 'F' is the maximum frictional force developed and the braking distance is l, then work done against friction force in stopping the vehicle is $F \times l = fWl$, where W is the total weight of the vehicle

The kinetic energy at the design speed of v m/sec will be

$$\frac{1}{2}mv^2 = \frac{Wv^2}{2g}$$

Hence,
$$fWl = \frac{Wv^2}{2g}$$

$$\Rightarrow l = \frac{v^2}{2gf}$$

Here, l = breaking distance

v = speed of vehicle, m/sec

f = design coefficient of friction (0.35 to 0.4)

g = acceleration due to gravity

$$S.SD = \text{Lag distance} + \text{Breaking distance}$$

$$= vt + \frac{v^2}{2gf}$$

If speed is V kmph, stopping distance,

$$SSD = \left[0.278\,Vt + \frac{v^2}{254f}\right]$$

Stopping distance at slopes:

Breaking ~~Bearing~~ distance $= \frac{v^2}{2g(f \pm 0.01n)}$

S.S.D = lag distance + Breaking ~~Bearing~~ distance

$= vt + \frac{v^2}{2g(f \pm 0.01n)}$

When v is in kmph,

$S.S.D = 0.278\, vt + \frac{v^2}{254(f \pm 0.01n)}$

07, 08

Q. Discuss the importance of sight distance.

Importance of sight distance:

i) Sight distance reduces the possibility of collision

ii) It helps the drivers to run at design speed

iii) It is a vital factor for safe vehicle operation

iv) It helps to reduce traffic jam.

v) It is essential for fast moving vehicles to overtake or pass slow moving vehicles.

1. Define overtaking sight distance. what are the factors affecting OSD.

Overtaking sight distance:

The minimum distance of the driver of a vehicle intending to overtake slow vehicle ahead with safety against the traffic of opposite direction is known as minimum overtaking sight distance or passing sight distance.

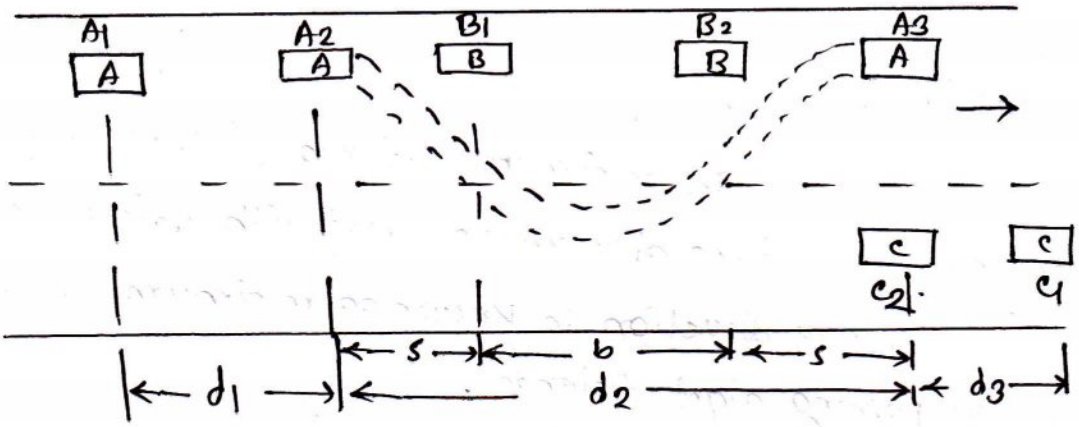
Factors affecting minimum OSD are:

i) Skill and efficiency of the driver intending to overtake
ii) Spacing between both vehicles
iii) Speeds of the vehicles namely overtaking, overtaken and vehicle coming from opposite direction
iv) Acceleration rate of overtaking vehicle

Q.

04, 10

Q. Derive an expression for calculating OSD.



In the figure,

A = overtaking vehicle and A_1, A_2, A_3 are its different position

B = overtaken vehicle and B_1, B_2 are its different position

C = Vehicle coming from opposite side and C_1, C_2 are its different position

V_b = speed of vehicle B

V = design speed of vehicle A and C

If, t = Time taken by A to move A_2 from A_1

T = " " " A to move A_3 from A_2

Then,

$$d_1 = V_b t \quad \ldots \quad (i)$$

The distance s is obtained from imperical formula,

$$s = (0.7 V_b + 6)\ m$$

Hence,

$$d_2 = V_b T + \frac{1}{2} a T^2 \quad (ii)$$

Also, $d_2 = 2s + b = 2s + V_b T$ (iii)

From (ii) and (iii)

$$T = \sqrt{\frac{4s}{a}} \quad (iv)$$

and $d_3 = VT$ --- (v)

Thus,

$$OSD = d_1 + d_2 + d_3$$

$$= v_b t + v_b T + \frac{1}{2} a T^2 + VT .$$

05,10

Q. What is overtaking zone? Draw a neat sketch of overtaking zone.

Overtaking zone:

The overtaking opportunity for vehicles moving at design speed should be given at frequent intervals. These zones which are made for overtaking are called overtaking zone.

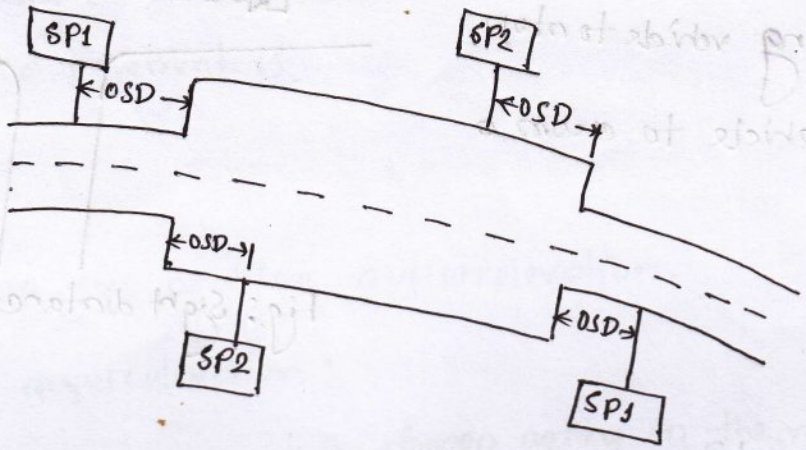


Fig: Overtaking zone

Here,

OSD = Overtaking sight distance

SP1 = Sign post (overtaking zone ahead)

SP2 = Sign post (end of overtaking zone)

Q. write short note on sight distance at intersection.

Sight distance at intersections:

It is important that on all approaches of intersecting roads, there is a clear view across the corners from a sufficient distance so as to avoid collision of vehiles. This is all the more important at uncontrolled intersections.

The design of sight distance at intersections may be based on three possible conditions;

i) Enabling the approaching vehicle to change speed.

ii) Enabling approaching vehicle to stop

iii) Enabling stopped vehicle to cross a main road,

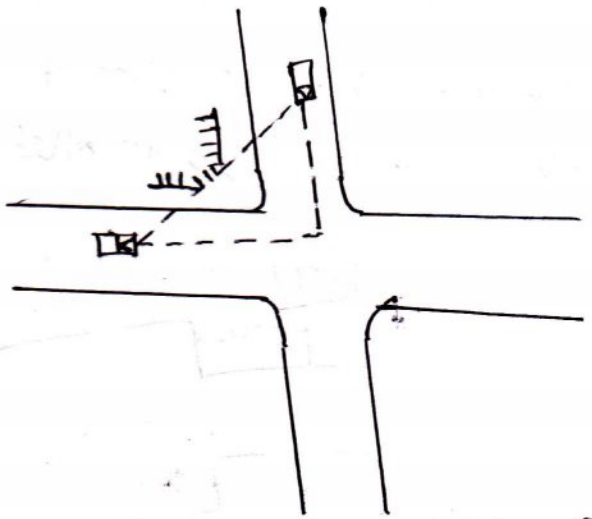


Fig: Sight distance at intersection

Q. Define super elevation.

10

Superelevation: (Cant/Banking)

Inorder to counteract the effect of centrifugal force and to reduce the tendency of the vehicle to overturn or skid, the outer edge of the pavement is raised with respect to the inner edge, thus providing a transverse slope throughout the length of the horizontal curve. This transverse inclination to the pavement surface is known as super-elevation or cant or banking.

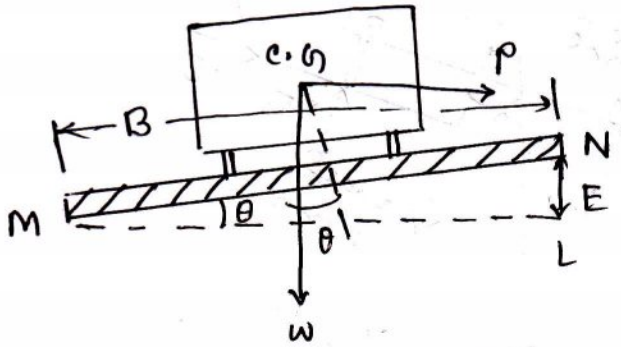


Fig: Supercelerated pavement section

From figure, $e = \frac{NL}{ML} = \tan\theta$ [value of $\tan\theta$ seldom exceeds 0.07]

θ is very small, $\tan\theta = \sin\theta$

$$e = \tan\theta \simeq \sin\theta = \frac{E}{B}$$

which is measured as the ratio of the relative elevation of the outer edge E to width of pavement B.

Q. How can you analyse supercelevation.

Analysis of supercelevation:

The forces acting on the vehicles while moving on a circular curve of radius R meters, at speed of V m/sec are

i) the centrifugal force $P = \frac{WV^2}{gR}$ acting horizontally outwards through the centre of gravity CG.

ii) the weight W of the vehicle acting vertically downwards through the CG.

iii) the frictional force developed between the wheels and the pavement counteractions transversely along the pavement surface towards the center of the curve.

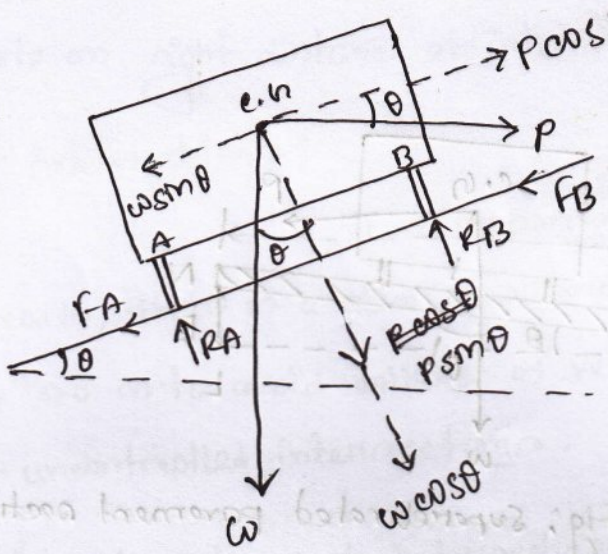


Fig: Analysis of superelevation

For equilibrium condition,

$$P\cos\theta = w\sin\theta + F_A + F_B \qquad \left[\begin{array}{l} F_A = fR_A \\ F_B = fR_B \end{array}\right]$$

$$\Rightarrow P\cos\theta = w\sin\theta + f(R_A + R_B)$$

$$\Rightarrow P\cos\theta = w\sin\theta + f(P\sin\theta + w\cos\theta)$$

$$\Rightarrow P\cos\theta = w\sin\theta + fP\sin\theta + fw\cos\theta$$

$$\Rightarrow P(\cos\theta - f\sin\theta) = w(\sin\theta + f\cos\theta)$$

$$\Rightarrow \frac{P}{w}(1 - f\tan\theta) = \tan\theta + f$$

$$\Rightarrow \frac{P}{w} = \frac{\tan\theta + f}{1 - f\tan\theta}$$

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If $\tan\theta$ very small then $\tan\theta = \theta$

But, $\frac{P}{w} = \frac{v^2}{gR}$

$$\frac{v^2}{gR} = \tan\theta + f$$

$$\Rightarrow e + f = \frac{v^2}{gR}$$

If v in kmph then, $e+f = \frac{(0.278v)^2}{9.81R} = \frac{v^2}{127R}$

CE-351

Traffic Engineering

AHSAN HABIB
090063

Q-1: What do you mean by traffic engineering.

Traffic Engineering:

Traffic engineering deals with the planning, designing and operating traffic systems to achive safe and efficient movement of persons and goods.

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Q-2: What are the objectives and scope of traffic engineering?

Basic objectives:

To achive efficient, free and rapid flow of traffic with least number of traffic accidents.

Scope:

Traffic engineering may be divided into the following seven sections:

i) Traffic characteristics

ii) Traffic studies and analysis

iii) Traffic operations control and regulation

iv) Planning and analysis

v) Geometric design

vi) Administration and managment

vii) Research

Q. Traffic characteristics:

i) Road users characteristics

ii) Vehicular ,,

iii) Road ,,

07

Q. What are the road users characteristics? Discuss briefly the various factors which affect the road user characteristics and their influence in traffic performance.

Road users characteristics:

Pedestrians, cyclist, vehicle drivers, bullock-cart drivers, all are called road users.

1. Physical Characteristics:

a) Permanent characteristics: Vision, hearing power, strength, general reaction to traffic situation, reaction time etc

b) Temporary characteristics: ~~Knowledge, skill, intelligence, experience and literacy~~. Fatigue, Alcohol, Drug, Illness

Influence:

Various physical factors affect traffic performance. Traffic control devices are designed and installed considering vision. Hearing power is essential for pedestrians to avoid accidents. These factors also affects reaction time.

10

2. Mental Characteristics:

Knowledge, skill, intelligence, experience and literacy.

Influence:

Knowledge of vehicle characteristics, traffic behavior, driving practice etc is useful for safe traffic operations. Understanding the traffic rules and timely action depends on intelligence and literacy.

3. Psychological factors:

Impatience, inattentiveness, fair, anger, fear maturity, home worries mind.

Influence:

various psychological factors affect attentiveness and reactions to traffic situations. These also influence the tendency of regarding traffic rules and regulations.

4. Environmental factors:

Locality, shop. atmospheric conditions facilities to traffic etc.

Influence:

Locality such as business area or shopping mall and this like distractions affect the behavior of road users. weather visibility and other environmental factors also affect traffic operation.

00, 05, 10 (A+)

Q. What are the different characteristics of the vehicular traffic ~~with~~, which affect the road design. (C.L)

Vehicular Characteristics:

i) Static characteristics

ii) Dynamic characteristics

i) Static characteristics:

width, height, length, weight and maximum turning angle.

width → affects the width of lane, shoulders and parking spaces.

length → affects the extra widening, passing side distance, parking capacity

height → affects the clearence to be provided under structure, under bridge, electric service line, tunnel

weight → affects pavement thickness, limiting gradient

maximum turning → affects the design of sharp curves

ii) Dynamic characteristics:

Speed, acceleration, breaking characteristics

Speed → affects the horizontal and vertical alignment design, super elevation, limiting radius

Power → affects the limiting gradient, and total resistance to traction

Break → affects the stopping distance, overtaking distance and traffic capacity

Head light → affects the night operation and number of accidents in the night.

Q. Give maximum dimensions of road vehicles according to IRC (Indian Road congress) (k-163)

Vehicle Dimension	Particulars	Maximum dimension (m)
Width	All vehicles	2.50
Height	a) Single-decked vehicle	3.80
	b) Double-decked vehicle	4.75
Length	a) Single-unit truck	11.00
	b) Single-unit bus	12.00
	c) Semi-trailer tractor	16.00
	d) Tractor & trailers	18.00

Traffic Volume Study

02, 06, 07, 08, 10, 09 (A+)

Q. Define traffic volume. Mention the objectives of traffic volume studies.

Traffic Volume:

Traffic volume is the number of vehicles crossing a section of road per unit time at any selected period.

Objectives of traffic volume studies:

i) To measure the relative importance of roads
ii) For planning traffic operation and control of existing facilities.
iii) For structural and geometric design of pavement
iv) For the design of intersections and planning signal timings.
v) For planning side walks, cross walks, pedestrian signals

Q. Write short notes on:

i) PCU (K-189)

ii) DHV

iii) AADT

iv) Thirtieth highest hourly traffic

18.09

i) PCU:

The flow of traffic with unrestricted mixing of different vehicle classes on the roadways forms the heterogeneous traffic flow or the mixed traffic flow. The mixed traffic flow characteristics are very much complex when compared to homogenious traffic flow consisting of passengers cars only. It is difficult to estimate the traffic volume under mixed traffic flow, unless the different vehicle classes are converted to one common standard vehicle unit. It is a common practise to consider the passenger car as the standard vehicle unit to convert the other vehicle classes and this unit is called Passenger car Unit (PCU).

10

ii) DHV (Design Hourly Volume):

30th heighest hourly volume or design hourly volume (DHV) is the hourly volume that will exceeded only twenty nine hours in a year (8760 h) and all other hourly volumes will be less than this value. Road facilities designed according to peak hourly volume of the year will be uneconomical and those according to AADT will be inadequate for most of the time of the year. But those are according to 30th heighest hourly volume (DHV) is found to be satisfactory for both economic and adequacy point of view. Traffic jam on such road is expected for twenty nine hours in the year.

[Example দিয়ে বুঝাও]

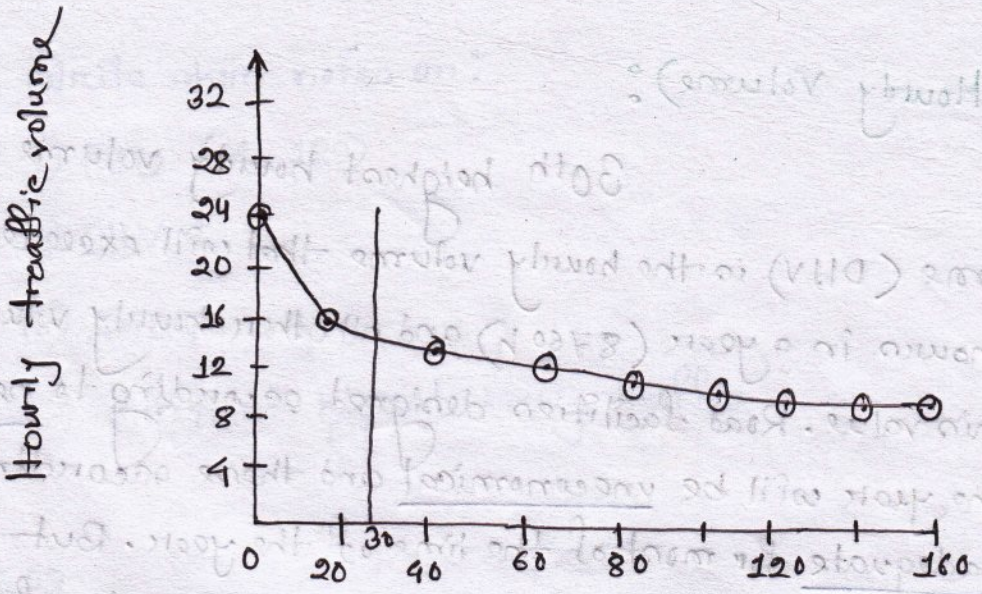
iii) AADT or ADT:

AADT means annual average daily traffic. It is the total annual flow of traffic divided by the number of days in the year. This helps in deciding relative importance of route and in phasing the road development program.

$$AADT = \frac{\text{Total annual flow of traffic}}{\text{No. of days in year}}$$

iv) 30th heighest hourly traffic:

Same as DHV



For example,

Let peak hourly volume = 1000 vehicles per hour

AADT = 4200 vehicle per day

From graph,

Traffic congestion (Hours)	Hourly traffic volume (vehicle per hour)
0	0.24 X 4200 = 1008
29	0.15 X 4200 = 630
160	0.12 X 4200 = 540

10

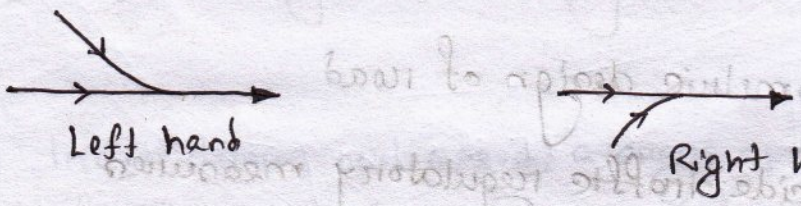
Q. Discuss different traffic flow characteristics or traffic manoeuvers (यातायात की विशेषताएं).

The basic traffic manoeuvers are —

i)

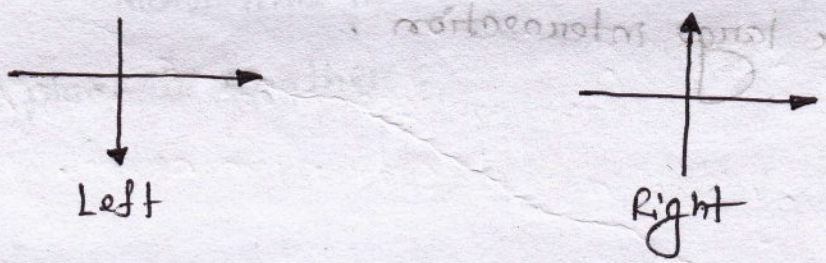
Diverging

ii)



Merging

iii)



Crossing

iv)

Weaving

Diverging on the left and merging from the left side does not cause much of conflict. But diverging to the right and also merging from the right create conflicts and hazard (বিপদ) to the traffic moving in the straight path. The crossing traffic is the greatest problem incase of road intersection at level.

Q. Mention the necessity of study of traffic flow characteristics.

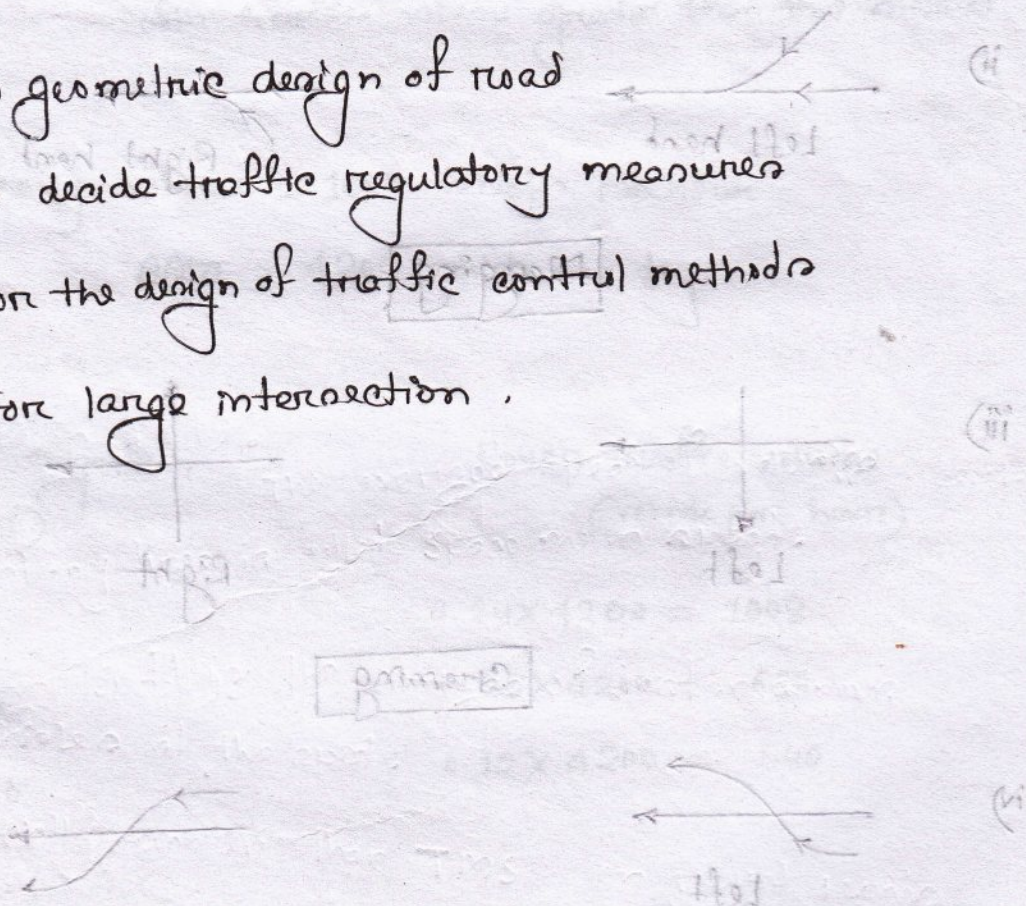
Study of traffic flow characteristics very much needed:

i) In geometric design of road

ii) To decide traffic regulatory measures

iii) For the design of traffic control methods

iv) For large intersection.



Speed Studies

Q. What are the purposes of speed studies.

Purposes of speed studies:

i) For planning speed zones, traffic sign and signals
ii) To determine the speed trends (प्रवृत्ति)
iii) To study the accident behaviour
iv) To study the traffic capacity
v) Useful on geometric design of road

Q. Define travel time, spot speed, average speed, running speed, travel speed

Travel time:

Travel time is the total time required for travel from one place to another.

Spot speed:

Spot speed is the instantaneous speed of a vehicle at a specified location.

Average speed: Average speed is the average of the spot speeds of all vehicles passing a given point on the highway.

i) Space-mean speed (SMS)

ii) Time-mean speed (TMS)

Running speed:

Running speed obtained by dividing the distance covered by the time during which the vehicle is actually in motion.

Overall speed or travel speed:

It is the speed obtained by dividing the distance covered by the ~~time during which the~~ total time taken including all delays and stoppages and travell time.

SMS (Space Mean Speed):

The average speed of vehicles, in a certain road length, at any time is called space mean speed.

TMS (Time Mean Speed):

It is the average of instantaneous speed of observed vehicles at the spot.

SMS is slightly smaller than TMS on rural roads.

Traffic capacity studies

Q. Define traffic density.

Traffic density:

It is the number of vehicles in one kilometre length of road. Its unit is vehicles/km. The heighest traffic density will occure when the vehicles are practically at a standstill on a given route.

Q. Discuss about traffic capacity.

Traffic capacity:

Traffic capacity is the ability of a roadway to accommodate traffic volume. It is expressed as the maximum number of vehicles on road that can pass a given point in one hour. Its unit is vehicles/hr.

i) Basic capacity
ii) Possible capacity
iii) Practical capacity

i) Basic capacity:

Basic capacity is the maximum number of vehicles that can pass a given point on the road during one hour in most ideal traffic condition. Two roads having the same physical features will have the same basic capacity. Basic capacity is the theoretical capacity.

ii) Possible capacity:

Possible capacity is the maximum number of vehicles that can pass a given point on the road during one hour under the prevailing roadway and traffic condition. Possible capacity of a road is much lower than basic capacity. Value of possible capacity varies from zero to basic capacity.

10

iii) Practical capacity or design capacity:

It is the maximum number of vehicle that can pass a given point on the road during one hour under prevailing road way and traffic condition, without unreasonable delay and hazard.

10.09

Q. Define TPF.

TPF (Traffic projection factor):

It gives the ultimate volume at the end of the design period interms of current traffic volume.

$$A = P(1+r)^{N+n}$$

where,

A = Traffic volume for design

P = Traffic volume at last count

r = Annual rate of increase in traffic

N = Design life; yr

n = construction period in year

Q. How can you determine theoratical maximum capacity. (K-185, S-272)

Determination of theoretical maximum capacity:

i) Theoretical maximum capacity can be obtained if the minimum time headway (H_t) is known

$$C = \frac{3600}{H_t}$$

ii) Theoretical maximum capacity of a traffic lane can be estimated by following formula -

$$C = \frac{1000\,V}{S}$$

Where, C = capacity of a single lane, vehicle per hour

V = speed kmph

S = average centre to centre spacing of vehicles in m.

Q. Discuss level of service according to HCM.

According to HCM (Highway capacity Manual) there are six levels of services A, B, C, D, E and F.

Level of service A:

It is a condition of free flow with high speeds and road traffic volume.

Level of service B:

It is a condition of stable flow and drivers have reasonable freedom to select their speed.

Level of service C:

It is a condition of stable flow but most drivers are restricted in their freedom to change lanes, overtake.

Level of service D:

It is a condition of unstable flow with nearly all drivers restricted.

Level of service E:

It is a condition of unstable flow with momentary stoppage.

Level of service F:

It describes forced flow operation at low speed.

Parking study

06,07,08

Q. What is parking study? Discuss its object.

Parking study:

The demand of parking space is one of the major problems in big cities. In industrial, commercial and residential places with multistoried buildings parking demand in particularly high. Vehicles each in properly packed cause lot of problems like traffic congestion (যানজট), accident, obstruction to fire fighting operation, environmental pollution. Parking study includes these problems, their solution and other parking related aspects like parking demand,

space inventory, parking practices etc

Objects of parking study:

i) To satisfy parking demand of vehicles
ii) To minimize parking problems
iii) To improve existing parking facilities
iv) To minimize accident rate due to parking and unparking operation.

04.09

Q. Explain briefly various aspects investigated during parking studies.

Following aspects should be investigated during parking studies:

i) Parking demand:

Parking demand is estimated and recording the peak demand for parking facilities.

ii) Space inventory:

All the existing parking facilities and open spaces available for adopting as parking places are recorded.

iii) Parking practices:

Parkers should be interviewed to know how many people would like to bring their cars if parking facility is provided.

iv) Parking characteristics:

a) Present practice of parking
b) Problems faced during parking
c) Interference to smooth flow of traffic
d) Accidents involved during parking and unparking operations.

00, 02, 10

Q. What are the various types of parking facilities designed for traffic needs?

Types of parking facilities:

There are two types of parking facilities designed for traffic need as -

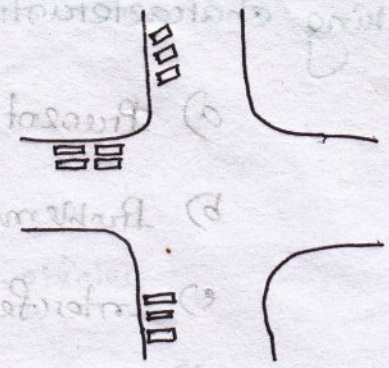
i) On-street parking or kerb parking
ii) off-street parking

i) On-street parking or kerb parking:

Vehicles are parked along the kerb which is very convenient for the parkers due to near the place of their business. Since kerb parking may lead to traffic congestion and be possible cause of accidents they should be designed for adequate capacity. It may be restricted or unrestricted.

Various patterns of kerb parking are –

1) Parallel parking
2) Normal »
3) Angle »



ii) off-street parking:

off-street parking is provided at a separate place away from the road kerb.

Types of off-street parking:

1) Surface kerb parking
2) Multistory » »
3) Roof parking
4) Under ground parking
5) Peripheral parking schemes
   a) Park and walk
   b) Park and ride
   c) Good bye and ride

Q. What are the advantages and disadvantages of off-street parking.

Advantages:

i) No undue congestion and delay on the road.

ii) Does not harm the capacity of the road.

Disadvantages:

i) walking for reached their destination

ii) Not possible to provide at very close intervals

Q. What are the point should be kept in mind while designing an off-street parking.

The following points should be kept in mind while designing an off-street parking:

i) Exit and entrance to the parking place should be located far away from the intersection.

ii) These should be provided on unimportant or minor streets with less traffic flow.

iii) Vehicles entering and leaving the parking space should be diverge and merge at low speed.

iv) Exits should have adequate side distance

v) Parking place land should be available and cheap.

Q. Discuss the facilities of parking lot.

The parking lot should have the following facilities:-

i) Proper arrangement of lights

ii) Proper arrangement of drainage

iii) Parking lot should be smooth and hard

iv) There should be walkways for pedestrian at the exit and entrance.

01, 10

Q. Compare off street parking with kerb parking.

off-street parking	on-street / Kerb parking
i) Parking place is provided away from road kerb.	i) Road kerb acts as parking place.
ii) It does not lead to traffic congestion and accident	ii) It may lead to traffic congestion and accident.
iv) Parking cost is less	iii) This ~~test is~~ system is comparatively costly.

Road Accident/Traffic Accident

090063
AHSAN

Q. Define accident.

Accident:

Any occurance which affects or may affect the normal working is called accident.

Q. Define road accident.

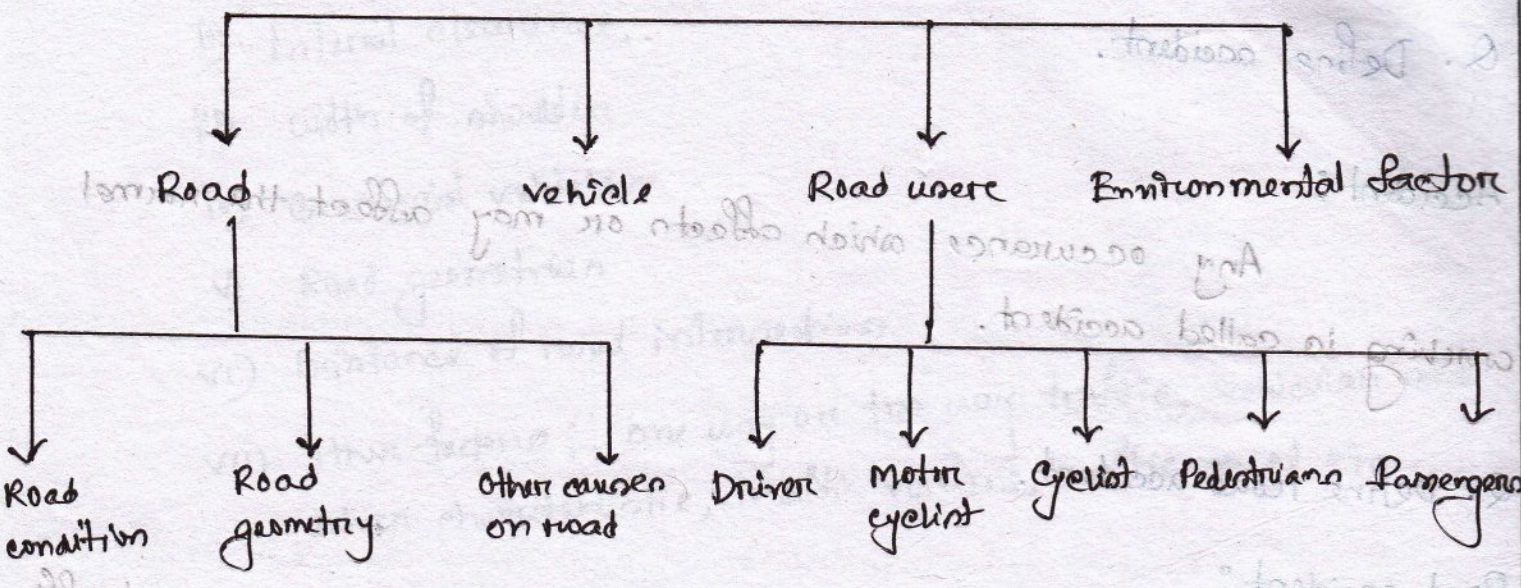
Road accident:

An accident which occured on a road open to public traffic resulting in either injury or loss of life or damage to property, in which atleast one moving vehicle was involved.

Everyday about 140000 people are injured on the world's road, more than 3000 die and some 15000 are disable for life. It is estimated that nearly 12000 people are killed on road every year in Bangladesh. Age of 80% killed are 5 to 45 years.

Q. what are the causes of road accident.

Causes of road accident:



1) Road :

a) Road condition:

Frictionless and uneven road surface, improper drainage of surface water, excessive camber, improper speed breakers, pot holes.

b) Road geometrics:

Inadequate side distance, inadequate width and carriageway and shoulders, improper design of horizontal curve and vertical curve, excess conflict point at intersection.

c) Other causes on road and road sides:

Improper signs, signals and road lighting, ribbone development, advertisement board, meeting, hut bazar,

attractive buildings and high lighting near road side, provocatively (উত্তেজক) dressed ladies, stray elements (বিপথগামী মানুষজন বস্তু), spreading of crops, straw, stake of construction materials, branch of tree overtreads.

ii) Vehicles :

It is said that vehicles are the biggest culprits that cause rollover accident. The vehicle characteristics that influence the road safety are break failure, steering failure, threadless tyre, light failure during night, age of vehicle, defective horn and mirrors, mixed traffic, overloading.

iii) Road user :

Driver : The driver is the key factor in most of the accident. The driver characteristics that influence the road safety are -

1) Excessive speed
2) Rash driving
3) Careless
4) Violation of rules and regulation
5) Temporary effects due to fatigue, sleep or drugs
6) Avoiding the safety belt
7) Impatients
8) Anger, weakness, immaturity, home worried mind, undue glance, mobile talk.

AACI ERCTV

The minimum accidents are caused by the drivers when –

i) Age in 40-45 years
ii) Gender: Female
iii) Matrimonial (वैवाहिक) status

Motor cycle and scooter riders:

The riders of a motor cycle or a scooter is very much vulnerable to accident because they are totally unprotected.

Measures for safety to motor cycle rider are –

i) Provision of rare view mirrors
ii) Provision to cover the rear wheel
iii) Driver and one pillion rider
iv) No pillion rider during learning.
v) Proper foot rest for the pillion.
vi) Rider must wearing the crashed helmet.
vii) Stoppage and standing at the extreme left of the carriageway.
viii) Carefully merging, diverging and crossing.
ix) No competition with other speedy vehicle.
x) No talk with pillion riders
xi) Younger not feel hero when ride.

PDN RSC NY

Cyclist:

Cycle become popular because—

i) consumes no energy
ii) Occupies less space
iii) Makes no noise
iv) Emits no pollutants

Usual causes for cycle accidents are—

i) Improper turn
ii) Violation of traffic law
iii) Double riding
iv) More than two cycles remain abreast (পাশাপাশি)
v) Defective breaks
vi) No night lamps and reflector

IDMNV

Pedestrian:

A large number of road accidents involved pedestrians (about 45%) of the fatalities in Bangladesh. Factors that affect the pedestrian safety are—

i) Personal factors: carelessness, illiteracy
ii) Road factors: light, footpath
iii) Time factors
iv) other factors: Age

Safety measures for pedestrian:

i) Provision of footpath
ii) Provision of barriers
iii) Provide pedestrian refuges (নিরাপত্তা)
iv) Provision of zebra crossing
v) Provision of over bridge or under pass
vi) Adequate street lighting
vii) Special guidence for school children.

Passengers:

Characteristics of passengers:

i) Alighting from or getting into moving vehicles
ii) Mounting on and hanging side of the vehicle.
iii) Pushing or walking on roof
iv) keeping head and hand outside
v) Talking with drivers and make bargaining for fare.
vi) Excited the drivers for overtaking.

Environmental factors:

i) Factors that make the road slippery - snow ice, rain water
ii) Factors that restrict the normal visibility of drivers are fog, smoke, heavy rainfall.

07

Q. Mention some preventive measures of traffic accident.

Measures for the reduction in accident rate:

i) Engineering measures

a) Road design
b) Maintenance of defective vehicles
c) Road lighting
d) Necessary improvement of road after accident

RMRN

ii) Enforcement measures:

a) Speed control
b) Traffic control
c) Training & supervision
d) Medical check up
e) observance of law and regulation

TMSO

09

iii) Educational measures:

a) Road safety education for school children, pedestrians & passengers.
b) Propaganda and exhortation
1) Poster campaign
2) campaign in local press
3) Short films exhibition on the television, broadcast in the radio
4) Use of imaginative and easing slogans
c) Safety drive

Q. How can you investigate accident.

Accident investigation:

i) Recording general observation

a) condition of pavement

CR

b) Relative position of vehicles

ii) Driver test

a) Breath and spiral fluid test for alchohol content

BT

b) Test on driver characteristics

iii) Vehicle test:

a) condition of brakes and steering

b) Essential accessories

CED

c) Details of dents

iv) Probable causes of the accident:

a) Type

b) Site condition

TSP

c) Position of vehicles and objects

v) Cost analysis:

a) Injuries and fatalities of person

IDT

b) Damages of vehicle and property

c) Traffic delay

03, 05

Q. Explain the steps involved in traffic accident studies

Accident studies:

Step-1: Collection of accident data

a) General information (Date, day, time, persons involve in the accident)
b) Location of accident
c) Details of vehicle involve
d) Nature of accident
e) Road and traffic condition
f) Primary causes of accident
g) Accident cost
h) Drivers conditions

Step-2: Accident report

The accident should be reported to police authorities who would take legal actions in accidents involving injuries or damage of properties.

Step-3: Accident records

Accidents records are maintained giving all particulars of the accident, location and other details by means of location file, spot map and collision diagram.

04, 06, 08

Q. Draw symbols generally employed in collision diagram.

- Motor vehicles moving ahead
- Motor vechicles backing
- Rear end collision
- Out of control
- Head on collision
- Property damage only
- Pedestrian
- Parked vehicle
- Fixed object
- Side swipe
- Fatal accident
- Personal injury

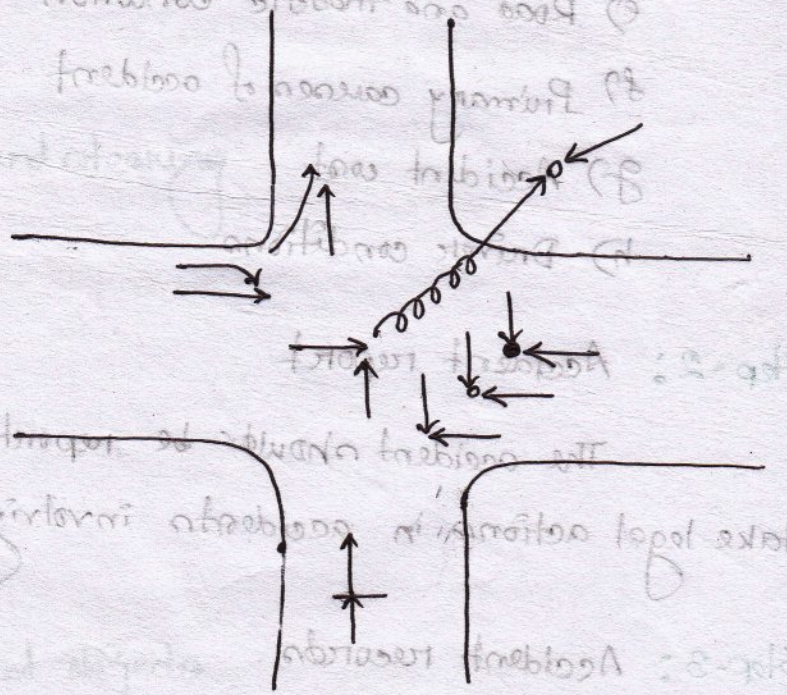


Fig: collision diagram

Q. Write short note on traffic operations.

Traffic operations:

For the safe traffic operation on highways adequate regulations and controls have to be imposed. The public should be assure that these regulation and controls are in their interest. The general requirements of traffic control devices are; attention, meaning, time for response and respect to road users.

Common devices are,

i) Traffic signs
ii) Traffic signals
iii) Road markings
iv) Traffic Island
v) Road light

Q. Write short note on traffic signs.

Traffic signs:

Traffic sign is a device mounted on a fixed or portable support to convey a specific information by means of words or symbol. Traffic sign divided into three categories:

i) Warning sign
ii) Regulatory sign
iii) Informatory sign

i) Warning sign: The shape of the sign is equilateral triangle. They have white background, red borders and black symbol.

ii) Regulatory sign: The shape of the sign is circular. They have white background, red borders and black symbol.

iii) Informatory sign:

Informatory signs are used to guide the road users along routes, inform them of direction and distance and provide with information to make travel easier, safe and pleasant.

a) Direction and place identification sign
b) facility information sign
c) other useful information sign
d) Parking sign.

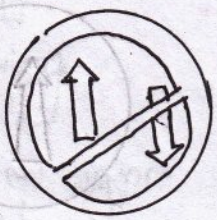
09,08

Q. With the sketches show various types of traffic signs.

1) Regulatory signs:

No entry

One way signs



Vehicles prohibited in both direction

Right turn prohibited

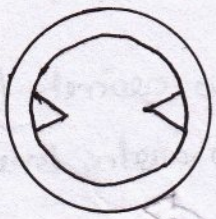
U-turn prohibited

Overtaking prohibited

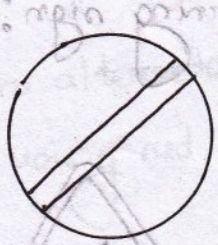
No parking

No stopping or standing

Speed limit

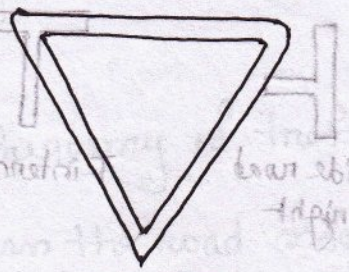


Width limit



Restriction ends sign

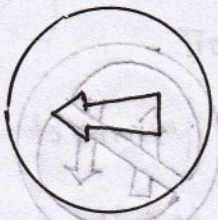
Stop



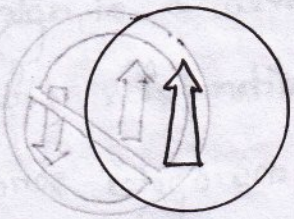
Give way

Fig: Regulatory signs

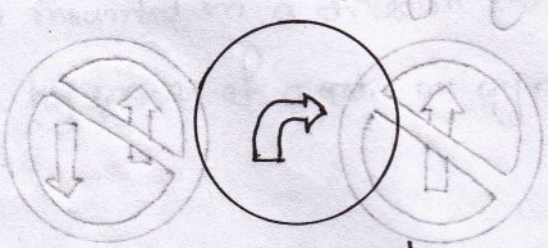
i) Regulatory sign:



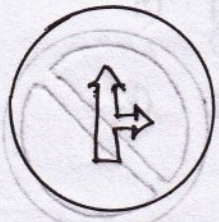
Compulsory turn left



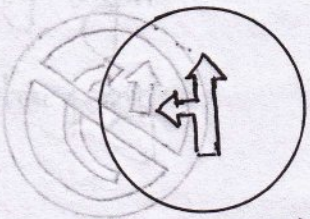
Compulsory ahead only



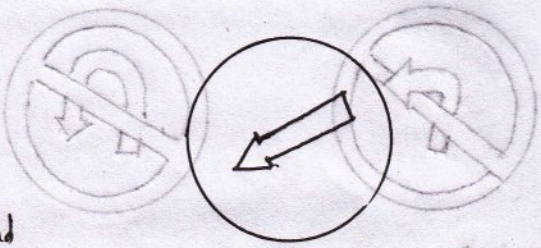
Compulsory turn right ahead



Compulsory ahead or turn right



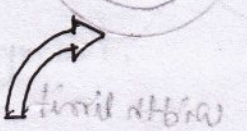
Compulsory ahead or turn left



Compulsory keep left

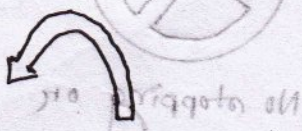
ii) Warning sign:

Typical cautionary sign



Right hand curve

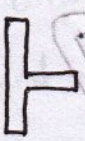
Left hand curve



Hair pin bend left

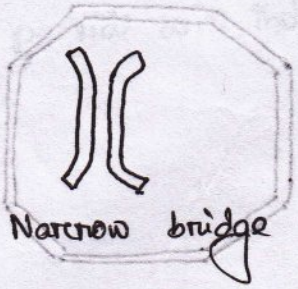
Reverse bend right

Cross roads



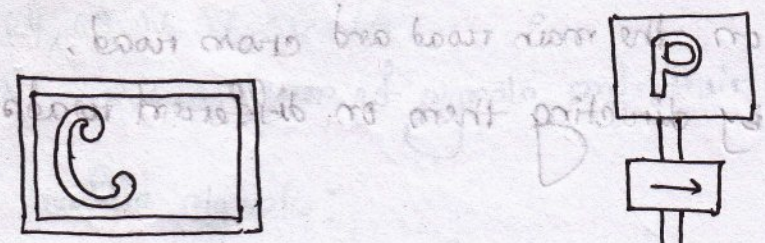
Side road right

T-intersection



Narrow bridge

fig: Warning sign



Facility information Parking

fig: Informatory signs

09

Q. Define traffic signals and their advantages and disadvantages.

Traffic signals:

At large intersection where there are a large number of crossing and right turned traffic, there is possibility of several accident. At small intersection, traffic is used to be controlled by traffic police alternately showing sign.

Traffic signals are such control devices which are alternately direct the traffic to stop and proceed at level intersections using red and green traffic light signals.

Advantages:

a) They provide orderly movement of traffic and increase the traffic capacity.

b) They reduce the frequency of traffic accidents.

c) Pedestrians can cross the road safely.

d) They control the speed on the main road and cross road.

e) They help the traffic by directing them on different roads.

Disadvantages:

a) They increase the chances of rare and collision.

b) Improper design and location may lead to violation of the control system.

c) Failure of signal due to electric power fail or other defects may cause confusion to road users.

d) At fixed interval signals, urgent vehicle wait only for showing red light but cross road is free.

03, 04, 05, 06, 07, 08, 10

Q. Explain various types of signals and their functions.

Type of traffic signals:

i) Traffic control signals
   a) Manually operated light signals
   b) Fixed time automatic signals
   c) Traffic actuated signals
ii) Pedestrian signals
iii) Special traffic signals

I) Traffic control signals:

Three coloured light are used for this purpose

function: These are used to give right of way to the pedestrians to cross a road.

ii) Pedestrian signals:

Road markings are used for this purpose.

function: These are used to give right of the way to the pedestrians to cross a road.

iii) Special traffic signals:

Flashing beacons are used for this function.

function: These are used to caution the traffic to stop before entering the market cross road especially in hilly areas.

Q. Define road marking.

Road marking:

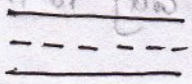
Road or traffic markings are made of lines, patterns, words, symbols or reflectors on the pavement, kerb, sides of islands or on the fixed object within or near the roadway.

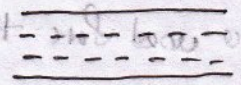
02, 06

Q. What are various types of road marking commonly used? What are the uses of each.

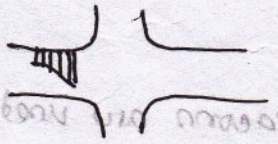
Types of road markings:

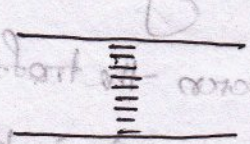
1. Pavement or carriageway markings

i) Centre lines 

ii) Lane lines 

iii) Route direction arrows 

iv) Stop lines 

v) Cross walk lines 

Use: To divide lanes of road, to indicate bus stop, to warn about no parking or no overtaking etc.

05,07,08,09

Q. What is traffic island? Name its various type and explain uses of each.

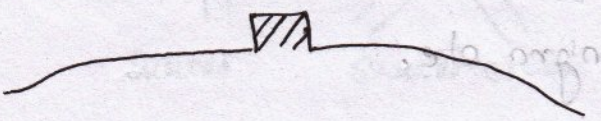
Traffic island:

Traffic island are rained area constructed within the roadway to establish physical channels through which the vehicular traffic may be guided to travel and avoid conflict.

Types of island:

Based on function traffic island are of three types as—

i) Divisional island:

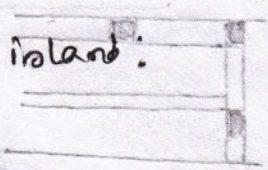


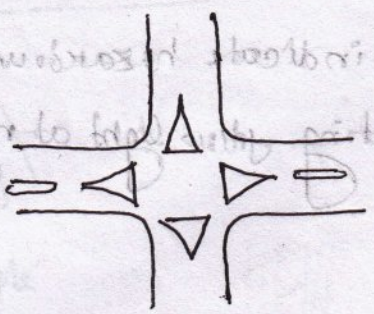
Uses:

i) To separate opposing flow of traffic in a road having four or more lanes.

ii) To reduce possibility of head on collision and other accidents.

ii) Channelizing island:





Uses:

i) To guide the motorist at turning point

ii) To serve as refuse island for pedestrians.

iii) Central island or rotary island:

Uses:

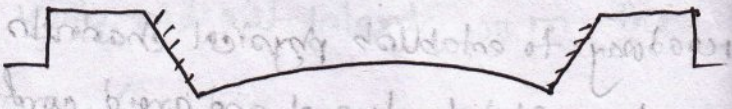
i) To guide the vehicles at their required direction safely.

ii) To serve as a refuse island.

2. Kerb markings:

These are the alternative black and white line marked on kerb and edges of island.

Use: To increase visibility from long distance at night.



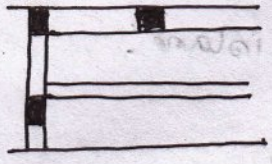
3. Object marking: These are markings on sign and signal posts, level crossing gates etc.

Use: To warn about the presence of level crossing narrow bridge, traffic signs etc.

4. Reflectors unit marking:

They are light reflecting marking on busy roads.

Use: To indicate hazardous obstructions by reflecting yellow light at night.



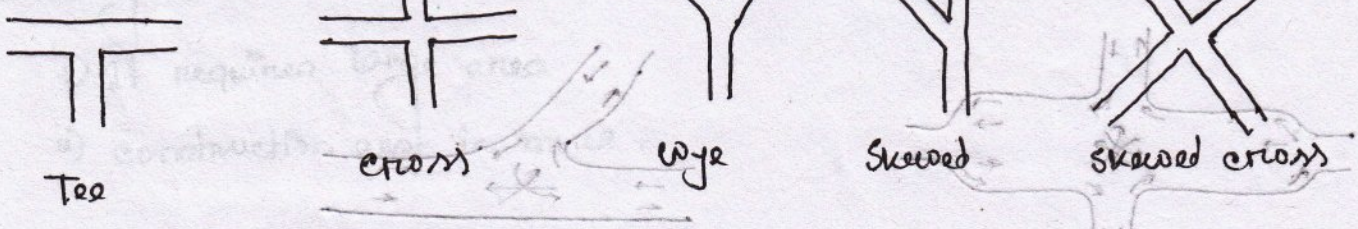
Q. Define road intersections.

Road intersection:

Road intersection or road junctions are the place where two or more roads cross each other at different angles.

Q. Draw different forms of intersection.

Forms of intersection:



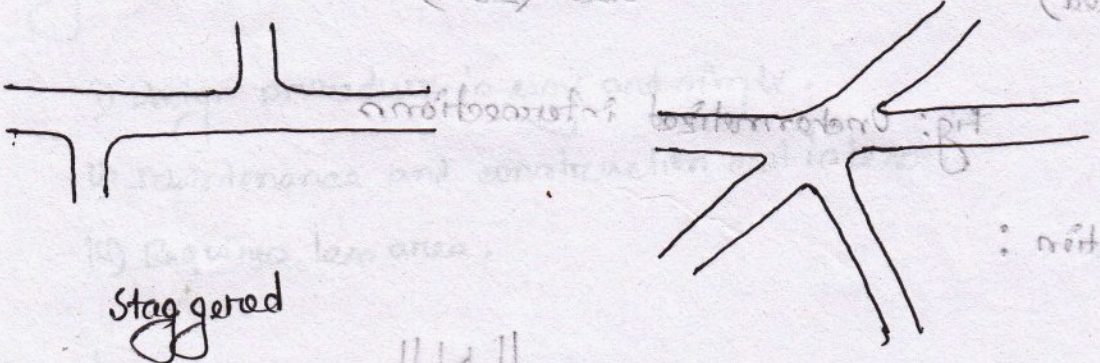


Fig: Forms of intersections

03, 04, 08, 09

Q. Draw a neat sketch of channelized and unchannelized road intersection and give their advantages and disadvantages.

Unchannelized intersections :

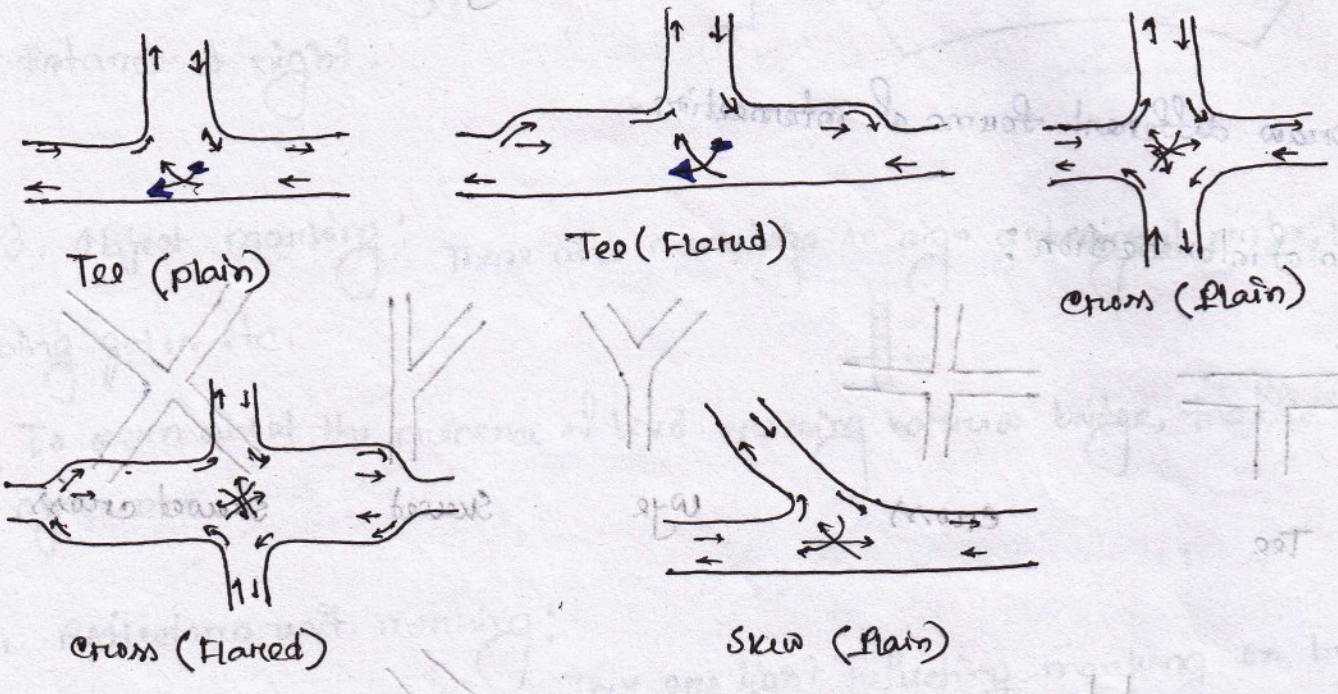
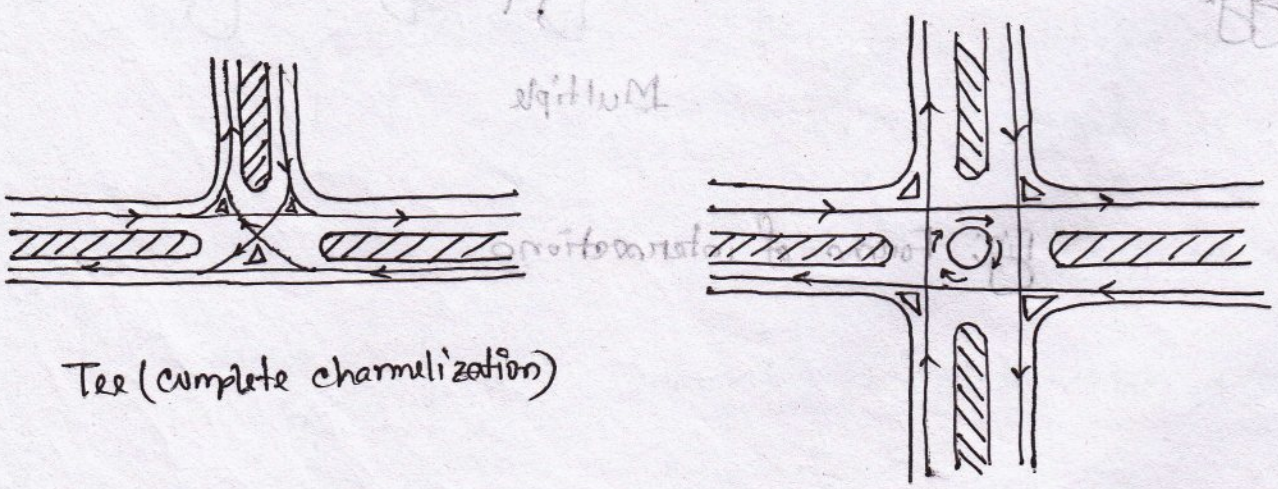


Fig: Unchannelized intersections

Channelized intersection :



Advantages of channelized intersection:

i) Vehicles can be confined to definite path

ii) Speed control can be established over vehicles entering the intersection.

iii) Refuge island can be provided for pedestrians within the intersection area.

iv) Points of conflicts can be separated.

v) Angle of merging is kept minimum

vi) Place for signs and signals can be provided.

Disadvantages:

i) It requires large area

ii) construction cost is more.

Advantages of unchannelized intersection:

i) Design procedure is easy and simple.

ii) Maintenance and construction cost is less.

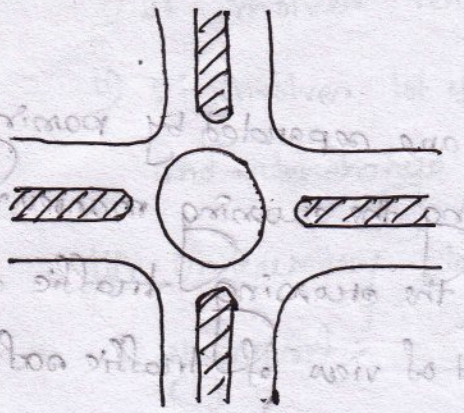
iii) Requires less area.

Disadvantages:

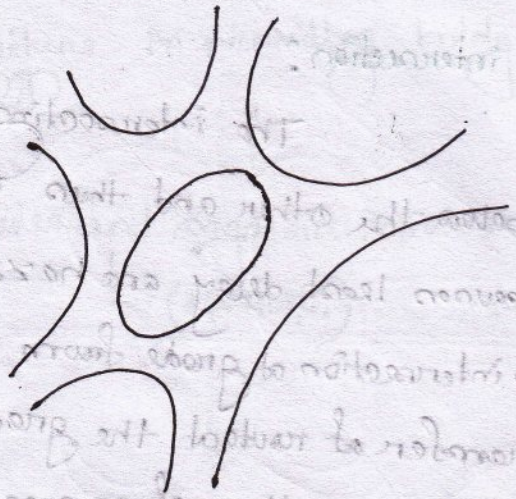
i) It has maximum conflict area

ii) Possibility of accident is more.

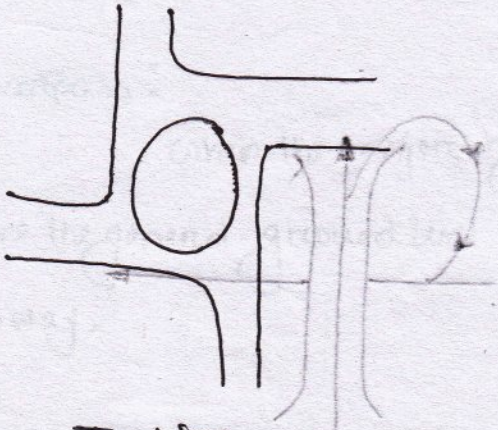
Q. Draw different shapes of rotary intersection.



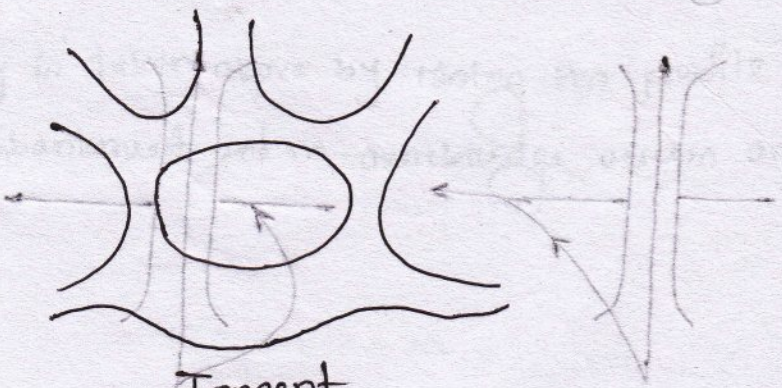
Circular



Elliptical



Turbine



Tangent

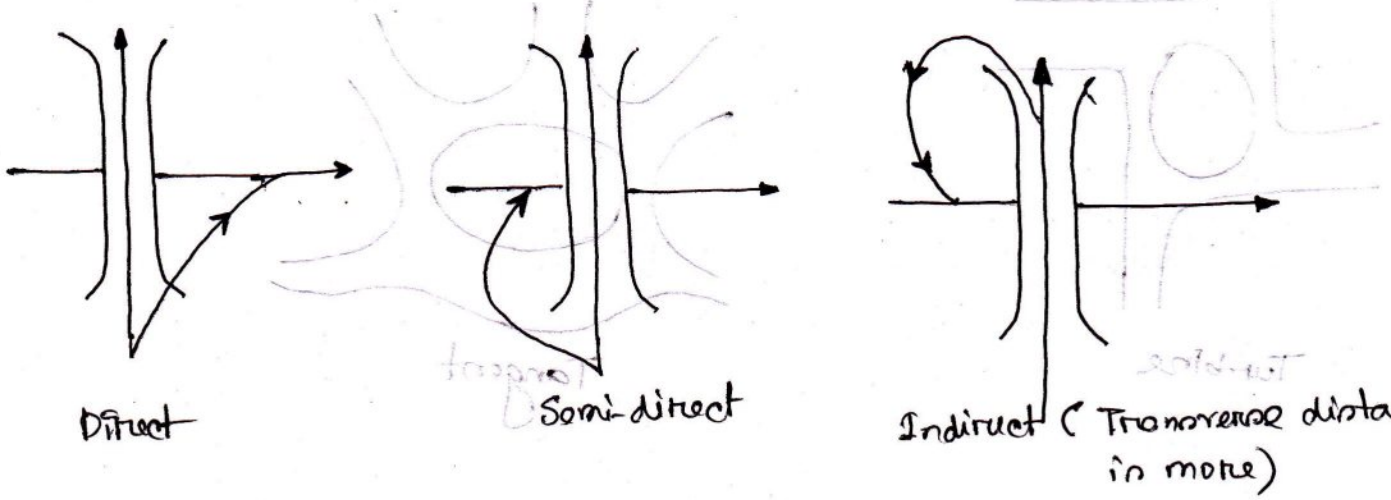
03, 05

Q. What is grade separated intersection? Write down its advantages and disadvantages.

Grade separated intersection:

The intersecting roads are separated by passing one road over or below the other and thus eliminating the crossing manoeuvres. This intersection causes least delay and hazzard to the crossing traffic and much superior to intersection at grade from the point of view of traffic safety and operation. Transfer of traffic at the grade separation is provided by the interchange facilities consisting of ramps.

Interchange ramps may be classified as:



Direct | Semi-direct | Indirect (Transverse distance is more)

Advantages:

i) Maximum facility is given to the crossing traffic
ii) There is increased safety for turning traffic
iii) They provide comfort and convenience to the drivers and saving the travel time and operation cost.
iv) It is essential part of controlled access highway like express way.
v) It can be designed for any angle of intersection.

Disadvantages:

i) It involves very large areas.

ii) It involves lot of expenditure in providing bridges, underpass (ব্যয়) and interchange ramps.

iii) Unnecessary rising grades and sags are introduced in vertical alignment. (বক্র পাথ্য)

09.08.07

Q. Write short note on i) Overpass, ii) Underpass, iii) Bypass, iv) Flyover

i) Overpass:

When the major highway is taken above by rising the profile above the general ground level by embankment and an overbridge across another highway.

Advantages:

i) Troublesome drainage problems may be reduced by taking the major highway above the cross road.

ii) When the wider road is taken above the span of the bridge being small, the cost of the bridge structure will be less.

Disadvantages:

i) In rolling terrain, if the major road is to be taken above, the vertical profile will also have rolling grade line.

ii) If the major highway is to be taken above over by constructing high embankments and by providing steep gradients, the increased grade resistance may cause speed reduction on heavy vehicles.

ii) Underpass:

When the highway is taken by depressing it below the ground level to cross another road by means of an under bridge.

iii) Bypass:

Bypass is an arrangement for diverging a traffic flow to avoid unnecessary hazzards.

iv) Flyover:

Flyover is a bridge over a large road intersection for safe traffic flow avoiding conflict.

Q. Draw the type of interchanges.

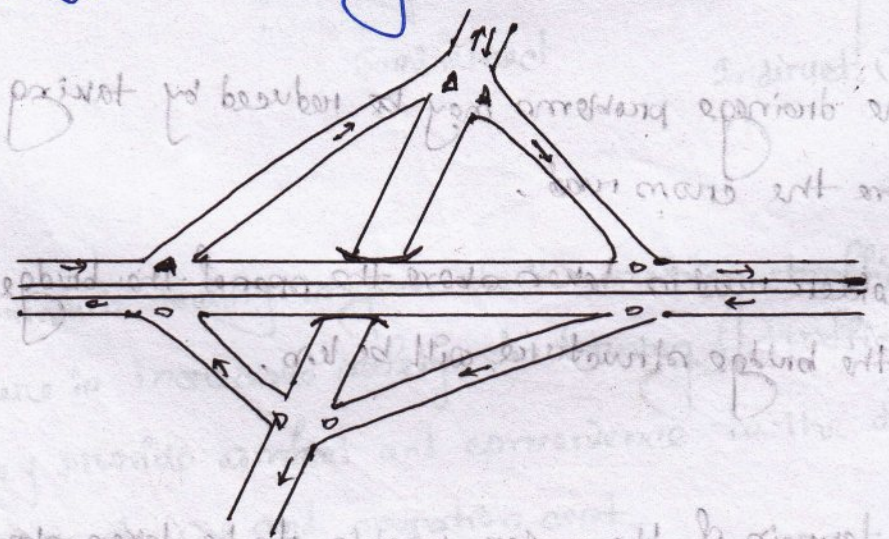
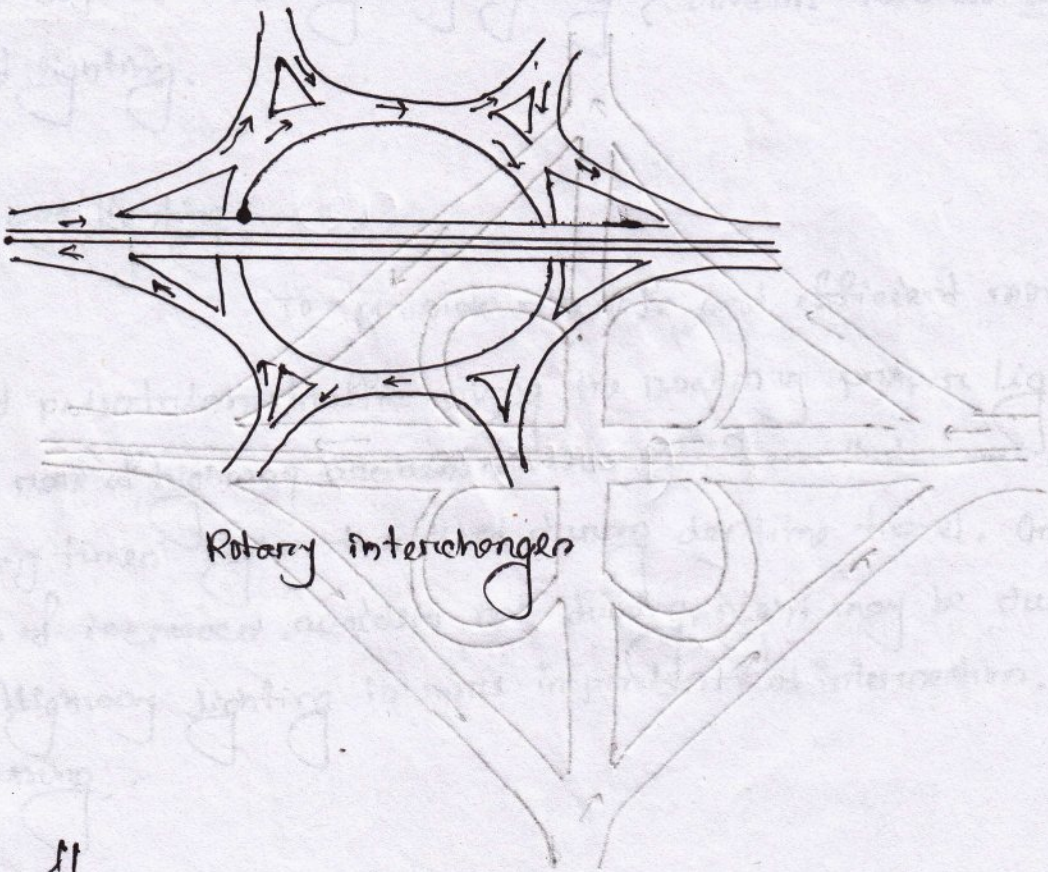
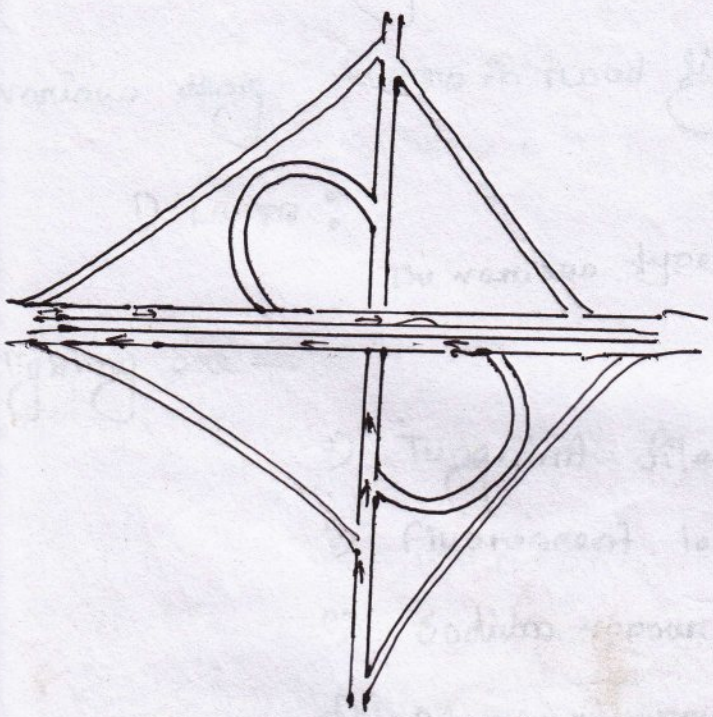


Fig: Diamond

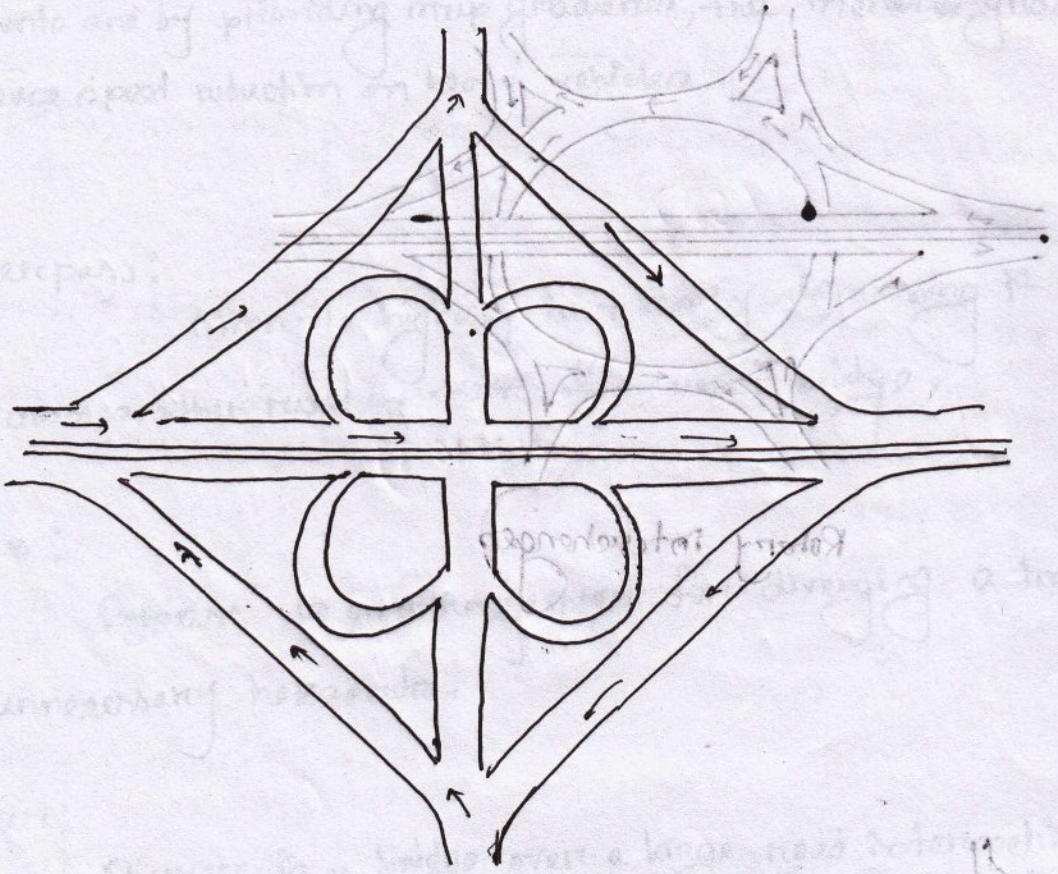


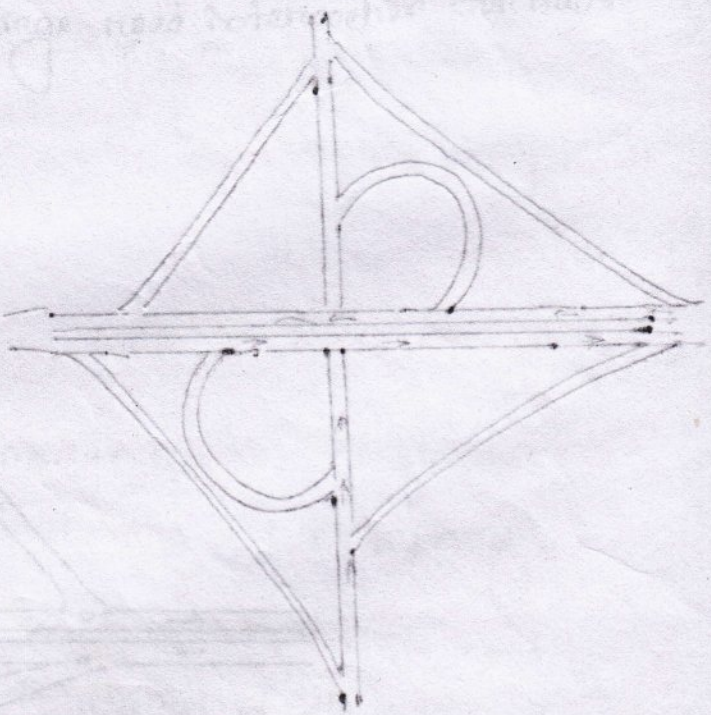
Rotary interchanges



Partial clover leaf

Full cover leaf:





Highway Lighting

10.09

Q. What are the objectives of highway lighting? Discuss various design factors in road lighting.

Objectives of highway lighting:

To promote the safe and efficient movement of vehicular and pedestrian traffic along the roadway proper Lighting is essential. The rate of highway accidents and fatalities that occure during night travel is many times higher than that during day time travel. One of the many reasons of increased accident rate during night may be due to the poore visibility. Highway lighting is more important at intersection, bridge site and level crossing.

Various design factors in road lighting:

1) Lamps:

The various types of lamps in use for highway lighting are —

a) Tungsten filament lamp

b) Fluorescent lamp

c) Sodium vapour lamp

d) Mercury vapour lamp

ii) Luminaire distribution of light:

To have the best utility of the luminaire or source of light, it is necessary to have proper distribution of light. The distribution should be downward so that high percentage of lamp light is utilized for illuminating the pavement and adjacent area.

iii) Spacing of lighting units:

Large lamps with high mountings and wide spacings should be preferred from economy point of view, spacing should be 3 to 5 times the mounting height.

iv) Height and overhang of mounting:

Mounting height varies from 6m to 10m and overhangs equal or less than 2m.

v) Lateral placement:

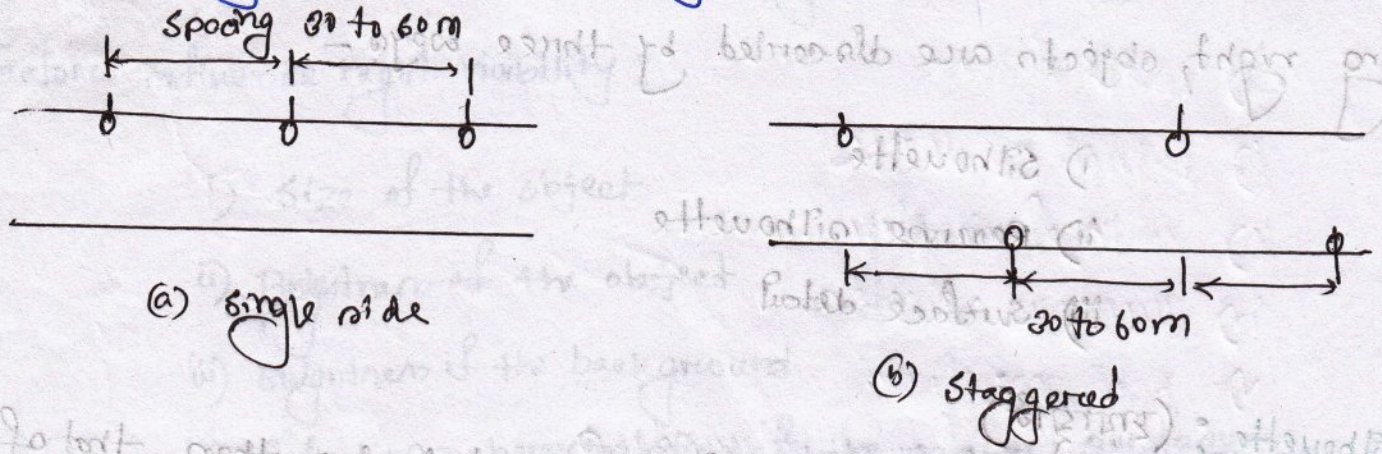
for urban roads → Minimum 0.3 m and desirable 0.6m from the edge of raised kerb

for rural roads → Minimum 1.5m from the edge of carriageway or minimum 5m from the centre line of the carriageway.

vi) Lighting layout

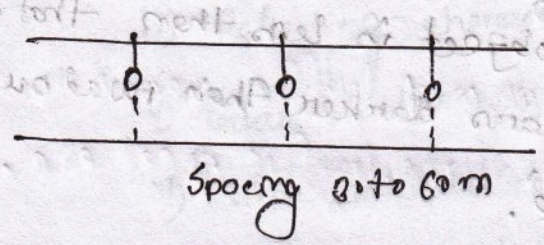
09, 08

Q. Show the light layout for straight road, kerb road, at intersection.



(a) Single side

(b) Staggered



(c) central

Fig: Lighting layout for straight road

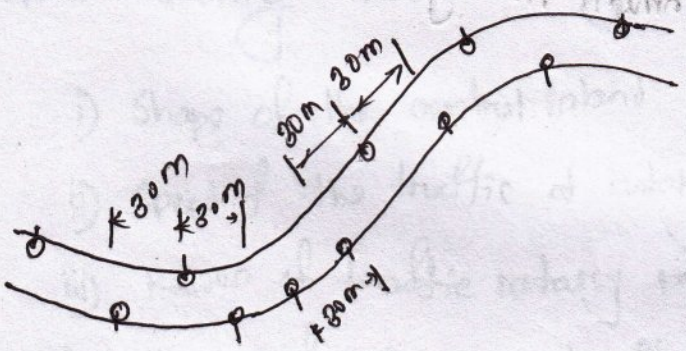
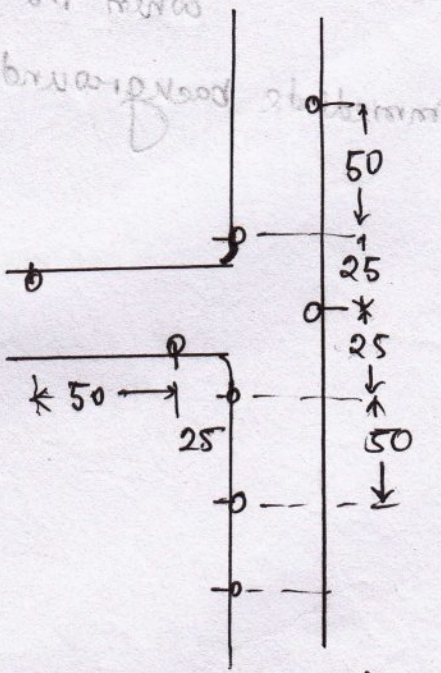


Fig: Lighting layout on horizontal curve



T- intersection

Fig: Lighting layout for intersection

09

Q. Write short note on silhouette, reverse silhouette.

During night, objects are discerned by three ways –

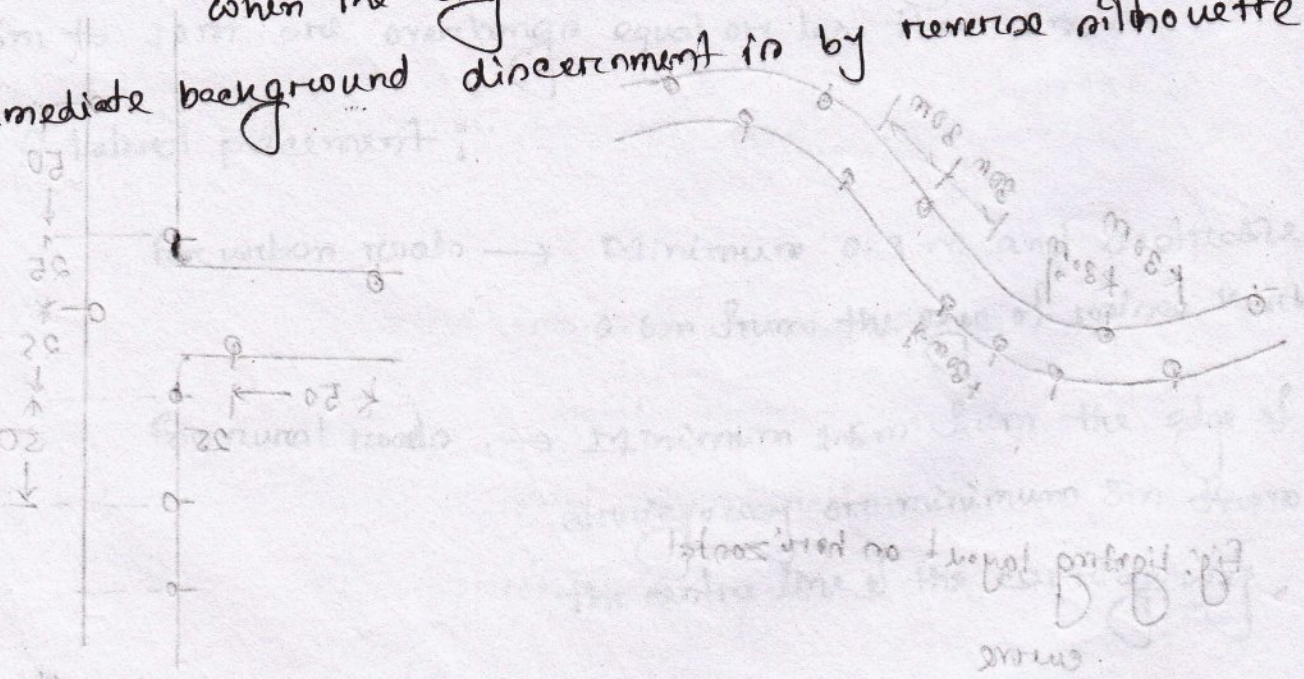
i) Silhouette
ii) Reverse silhouette
iii) surface detail

i) Silhouette : (চমৎকৃতি)

when the brightness of the object is less than that of the background, that is when the object appears darker than road surface discernment is principally by silhouette.
(বিচারবুদ্ধি)

ii) Reverse silhouette:

when the brightness of an object is more than that of the immediate background discernment is by reverse silhouette.



Q. What are the factors influence night visibility.

Factors influence night visibility:

i) Size of the object
ii) Brightness of the object
iii) Brightness of the background
iv) Reflecting characteristics of the pavement surface
v) Glare on the eyes of the drivers
vi) Time available to see the object
vii) Amount and distribution of light ~~flags from the land~~ flux from the lamps

Factors affecting traffic rotary.

i) Shape of the central island
ii) Speed of the traffic at rotary
iii) Radius of ~~traffic~~ rotary roadway
iv) Radius of entrance and exit curve
v) Width of rotary roadway
vi) weaving length and weaving angle
vii) channelizing island
viii) Design of camber, superelevation, grade, sign and lighting.

Road Accident/Traffic Accident

090063
AHSAN

Q. Define accident.

Accident:

Any occurance which affects or may affect the normal working is called accident.

Q. Define road accident.

Road accident:

An accident which occured on a road open to public traffic resulting in either injury or loss of life or damage to property, in which atleast one moving vehicle was involved.

Everyday about 140000 people are injured on the world's road, more than 3000 die and some 15000 are disable for life. It is estimated that nearly 12000 people are killed on road every year in Bangladesh. Age of 80% killed are 5 to 45 years.

07

090063 AHSAN

07

Problem : Calculate the safe stopping sight distance for design speed of 60 kmph for (a) Two way traffic on a two lane road, (b) Two way traffic on a single lane road. Assume co-efficient of friction 0.38 and reaction time as 2.5 sec.

Solution :

$$V = 60 \text{ kmph} = \frac{60 \times 10^3}{3600} = 16.67 \text{ ms}^{-1}$$

$$S.S.D = vt + \frac{v^2}{2gf}$$

$$= 16.67 \times 2.5 + \frac{(16.67)^2}{2 \times 9.81 \times 0.38}$$

$$= 78.95 \text{ m}$$

(a) Stopping sight distance for two lane road = 78.95 m

(b) " " " for single " " = $2 \times 78.95 = 157.9$ m (Ans).

10

Problem : Compute the minimum sight distance required to avoid a head on collision of two buses approaching from the opposite directions. The speed of both the buses in 70 kmh. Assume a total perception and break reaction time of 2.5 secs. coefficient of friction is 0.4 and break efficiency in 50%.

Solution :

$$V = \frac{70 \times 10^3}{3600} = 19.44 \text{ ms}^{-1}$$

$$f = 0.4 \times 0.5 = 0.2$$

The stopping distance for one bus $= vt + \frac{v^2}{2gf}$

$$= 19.44 \times 2.5 + \frac{(19.44)^2}{2 \times 9.81 \times 0.2}$$

$$= 144.91 \text{ m.}$$

SD to avoid head on collision of the two approaching buses

$= 2 \times 144.91$

$= 289.82$ m. (Ans).

Problem:

Calculate the stopping sight distances on a graded highway for a design speed of 90 kmh. Reaction time is 2 secs and value of f is 0.35.

a) when grade is 3% descending, b) when grade is 3% ascending

c) when road is flat i.e zero grade.

Solution:

$$V = \frac{90 \times 10^3}{3600} = 25 \text{ ms}^{-1}$$

a) $$S.S.D = vt + \frac{v^2}{2g(f \pm 0.01n)}$$

$$= 25 \times 2 + \frac{(25)^2}{2 \times 9.81 (0.35 \pm 0.01 \times 3)}$$

$= 149.55$ m

b) $$S.S.D = vt + \frac{v^2}{2g(f + 0.01n)}$$

$$= 25 \times 2 + \frac{(25)^2}{2 \times 9.81 \times (0.35 + 0.01 \times 3)}$$

$= 133.83$ m

c) Grade is Zero,

$$S.S.D = vt + \frac{v^2}{2gf} = 25 \times 2 + \frac{(25)^2}{2 \times 9.81 \times 0.35}$$

$= 141.01$ m (Ans).

Problem :

A road has an ascending gradient 4%. Design speed is 96 km/hr. Assume suitable data as on IRC recommendations. Determine stopping distance. $V = 100$ km/hr $t = 2.5$ sec $f = 0.4$

Solution :

$$v = \frac{100 \times 10^3}{3600} = 27.78 \text{ ms}^{-1}$$

$$S.D = vt + \frac{v^2}{2g(f + 0.01n)}$$

$$= 27.78 \times 2.5 + \frac{(27.78)^2}{2 \times 9.81 \times (0.4 + 0.01 \times 4)}$$

$$= 158.84 \text{ m} \quad \text{(Ans)}.$$

Problem :

The speeds of overtaking and overtaken vehicles are 80 and 65 km/hr respectively on a two way traffic road. If the acceleration of overtaking vehicle is 3.6 km/hr per second, calculate i) Safe overtaking sight distance ii) Minimum length of overtaking zone.

Solution :

$$V = \frac{80 \times 10^3}{3600} = 22.22 \text{ ms}^{-1} \qquad V_b = \frac{65 \times 10^3}{3600} = 18.06 \text{ ms}^{-1}$$

$$a = 3.6 \text{ km/hr/sec} = \frac{3.6 \times 10^3}{3600} = 1 \text{ msec}^{-2} \qquad t = 2 \text{ sec (Assume)}$$

$$OSD = d_1 + d_2 + d_3 = V_b t + V_b T + \frac{1}{2} a T^2 + V T$$

$$T = \sqrt{\frac{4s}{a}} = \sqrt{\frac{4 \times 18.64}{1}}$$

$$= 8.64 \text{ sec}$$

$$s = 0.7 V_b + 6$$
$$= 0.7 \times 18.06 + 6$$
$$= 18.64 \text{ m}$$

$$OSD = 18.06 \times 2 + 18.06 \times 8.64 + \frac{1}{2} \times 1 \times (8.64)^2 + 22.22 \times 8.64$$

$$= 421.46 \text{ m} \simeq 422 \text{ m}$$

Minimum length of overtaking zone $= 3 \times 422 = 1266$ m

Desirable " " $= 5 \times 422 = 2110$ m (Ans).