NEPAL ENGINEERING COUNCIL LICENSURE EXAMINATION

ER. SAURAV SHRESTHA
MSC. IN TRANSPORTATION ENGINEERING
PULCHOWK CAMPUS

TRANSPORTATION ENGINEERING SYLLABUS OF NEC LICENSE EXAM

9. Transportation **(ACiE09)**

9.1 Highway planning and survey: Modes of transport, history of road development in Nepal; classification of roads; road survey; highway alignment and controlling factors; evaluating alternate alignments; Road Standards of Nepal. (ACiE0901)

9.2 Geometric design of highway: basic design control and criteria; elements of highway cross-section; highway curves; super elevation; average and ruling gradients; stopping sight distance; design considerations for horizontal and vertical alignments, extra widening, and set back distance; design of road drainage structures; design considerations for hill roads. (ACiE0902)

9.3 Highway materials: types of aggregates and tests on their gradation, strength, durability; binding materials and their tests; design of asphalt mixes; evaluation of subgrade soil. (ACiE0903)

9.4 Traffic engineering and safety: impact of human and vehicular characteristics on traffic planning; traffic operations and regulations; traffic control devices; traffic studies (volume, speed, O&D, traffic capacity, traffic flow characteristics, parking, accident, flow); road intersections (types, configurations, design); traffic lights; factors influencing night visibility, road safety measures. (ACiE0904)

9.5 Road pavement: different types of pavement; design methods for flexible and rigid pavements (DOR Guidelines); loads and other factors controlling pavement design; stress due to load, temperature. (ACiE0905)

9.6 Road construction & maintenance: activities, techniques, tools, equipment and plants used in road construction; preparation of road subgrade; field compaction control and soil stabilization; construction of asphalt concrete layers; construction procedure for penetration macadam, bituminous bound macadam and plain cement concrete pavements; road maintenance, repair and rehabilitation. (ACiE0906)

DETERMINATION OF OPTIMUM BINDER CONTENT (OBC)

- It is done to ensure maximum stability. Stability is defined as resistance of paving mix to deformation under load.

1. Surface Area Concept
2. Void Concept Method

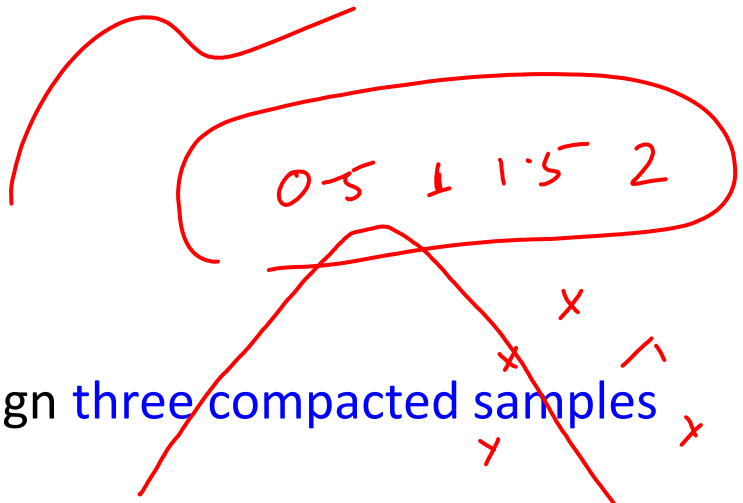
MARSHALL TEST AND DESIGN PROCEDURE

Used in designing and evaluation of bituminous paving mixes.

Major features of the Marshall method of designing mixes are to determine the two important properties of strength and flexibility.

In this test, an attempt is made to obtain optimum binder content for the type of aggregate mix used and the expected traffic intensity.

- **APPARATUS**
  - Mold Assembly: cylindrical moulds of 10.16 cm diameter and 6.35 cm height consisting of a base plate and collar extension
  - Sample Extractor: for extruding the compacted specimen from the mould
  - Compaction pedestal and hammer.
  - Breaking head.
  - Loading machine
  - Flow meter , water bath, thermometers



- In the Marshall test method of mix design three compacted samples are prepared for each binder content.
- At least four binder contents are to be tested to get the optimum binder content.
- All the compacted specimens are subject to the following tests:
  - Bulk density determination.
  - Stability and flow test.
  - Density and voids analysis.

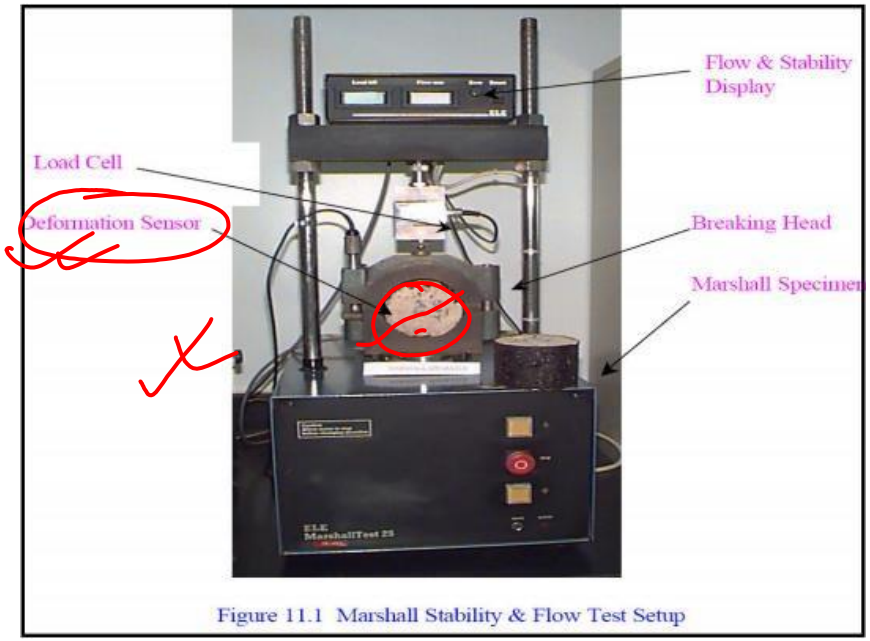
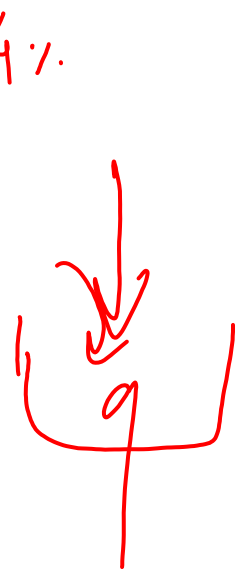


Figure 11.1 Marshall Stability & Flow Test Setup

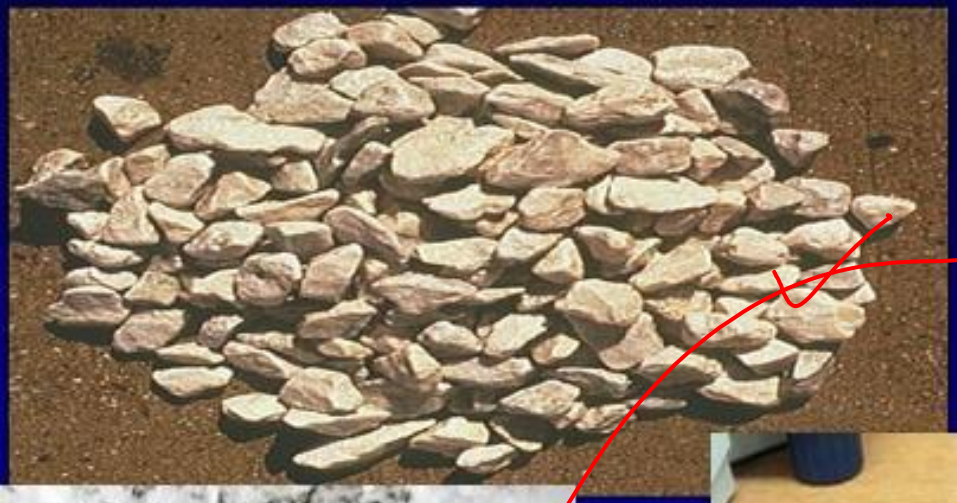
Figure 11.2 Marshall Specimen Extractor

PROCEDURE

- **Preparation of Test specimen**
  - Measure 1200gm of aggregates and heat upto 175°C to 190°C
  - Heat bitumen to a temperature of 121 – 125°C with the first trial percentage of bitumen (say 3.5 or 4% by weight of the mineral aggregates).
  - Mixed thoroughly the heated aggregates and bitumen at a temperature of 154 – 160°C.
  - Placed the mix in a preheated mould and compact by a rammer with 50 blows on either side at temperature of 138°C to 149°C.
  - After compaction extract the sample by pushing it out the extraction
  - Allow the sample to stand for a few hours to cool
  - Obtain the sample's mass in air and submerged to measure density of specimen, so as to allow calculation of voids properties
  - Vary the bitumen content in the next trial by 0.5% and repeat the above procedure.



- **Testing of Sample**
  - Specimens are heated to $60^{o} \pm 1^{o}$ in a water bath for 30 to 40 min
  - Remove the specimens from the water bath and place in the lower segment of the breaking head. Then place the upper segment of the breaking head on the specimen and place the complete assembly in position on the testing machine
  - Place the flow meter over one of the post and adjust it to read zero
  - Apply load at a rate of 50mm/min until the maximum load reading is obtained
  - Record the maximum load reading in N. at the same instant obtain the flow meter in units of mm.



+

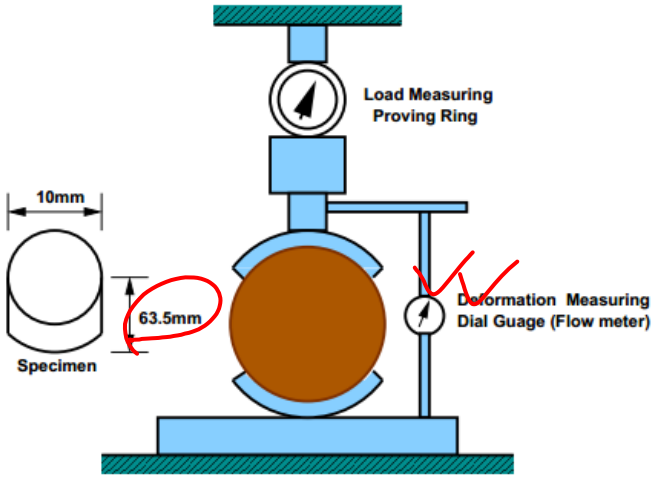
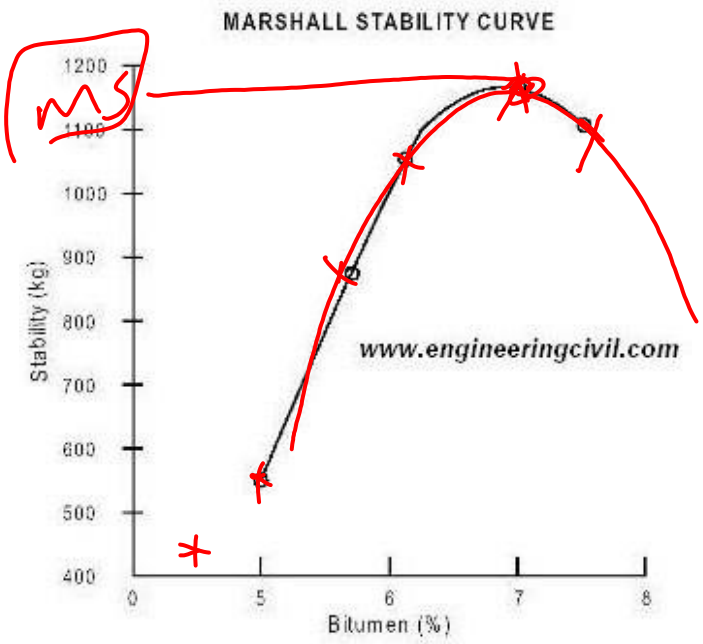
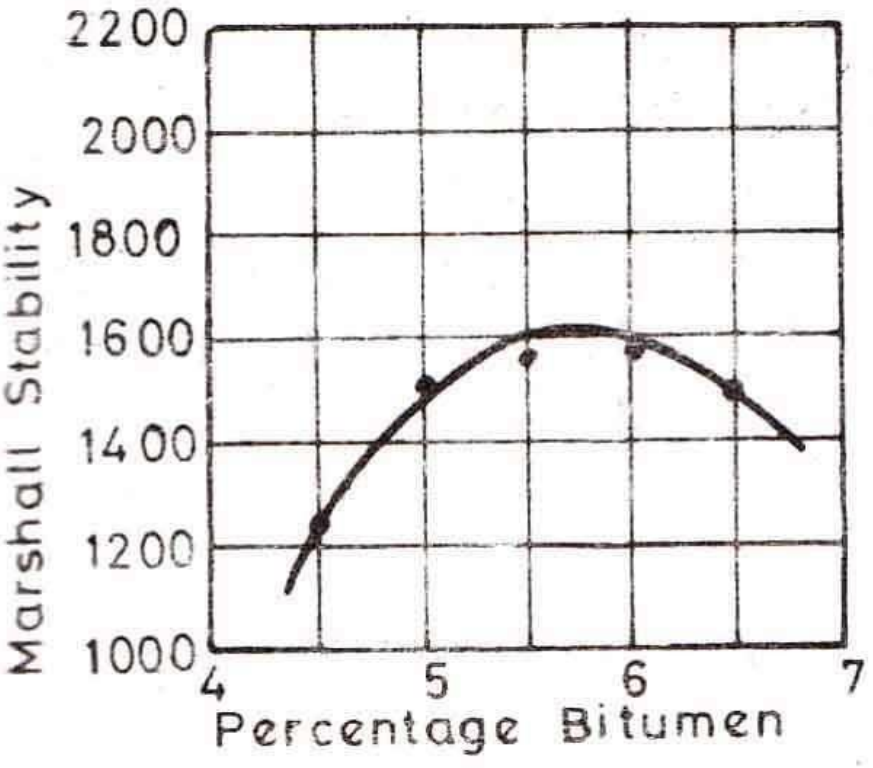
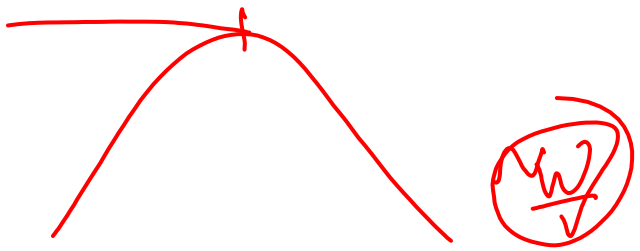


Figure 26:1: Marshall test setup



- The **stability of the mix** is defined as a maximum load carried by a compacted specimen at a standard test temperature of 60^0C.
- The **flow value** is measured as the deformation in units of 0.25mm between no load and maximum load carried by the specimen during stability test.


2200
2000
1800
1600
1400
1200
1000
Marshall Stability
4
5
6
7
Percentage Bitumen



- The optimum bitumen content for the mix design is found by taking the average value of the following three bitumen contents found from the graphs:

1. Bitumen content corresponding to maximum stability
2. Bitumen content corresponding to maximum unit weight
3. Bitumen content corresponding to the median of percent air voids in total mix.

- The Marshal stability value, flow value and percent voids filled with bitumen at the average value of bitumen content are checked with the Marshal mix design criteria given in table:

Test property	Specified value
Marshal stability , Kg	340 (minimum)
Flow value, 0.25mm units	8 to 16
Air voids in total mix, Vv %	3 to 5
Voids filled with bitumen, VFB%	75 to 85

1. Which of the following grade of bitumen is harder?
   a. 30/40
   b. 60/70
   c. 80/100
   d. All are equal

2. Medium curing cutback bitumen is fluxed with

A. Naptha

B. Petroleum

C. High boiling point Gas oil

D. Kerosene

3. The Phenomena in which the segregation of bitumen and aggregates takes place in the presence of moisture is called

A. Streaking

B. Slippage

C. Stripping

D. Rutting

1. The capability of aggregate to resist more weathering action and wheel load is called ….
   a. Hardness
   b. Toughness
   c. Soundness
   d. Strength
2. The sum of flakiness index and elongation index should not exceed _____
   a) 15
   b) 20
   c) 30
   d) 40
3. Which type of aggregate gives good workability ?
   a. Round
   b. Flaky
   c. Angular
   d. Irregular

1. The minimum grade of concrete required for pavement design is
   a. M30
   b. M35
   c. M40
   d. M45

TRAFFIC CHARACTERISTICS

Can be categorized into

❖ Road User Characteristics

Factors that affect road user characteristics are:

- Physical Characteristics
- Mental Characteristics
- Psychological Characteristics
- Environmental Factors

❖ Vehicular Characteristics

Static Characteristics

- Vehicle Kinematics
- Dynamic Characteristics

ROAD USER CHARACTERISTICS

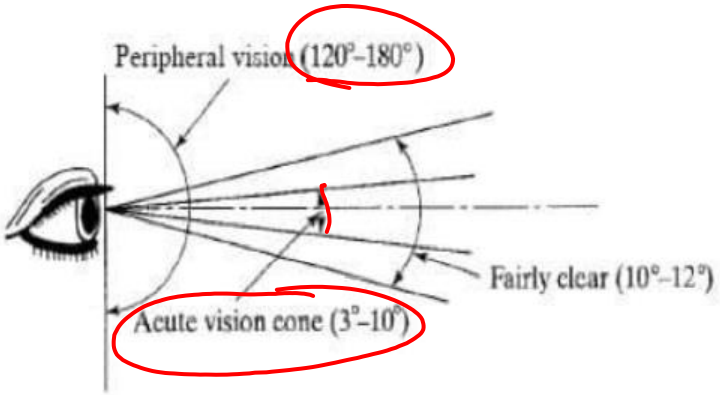
Physical Characteristics

Permanent characteristics

- vision and sensing
- hearing and smelling
- sex

Temporary characteristics

- alcoholic drink effect
- drug effect
- accident proneness
- fatigue, illness



Vision and sensing

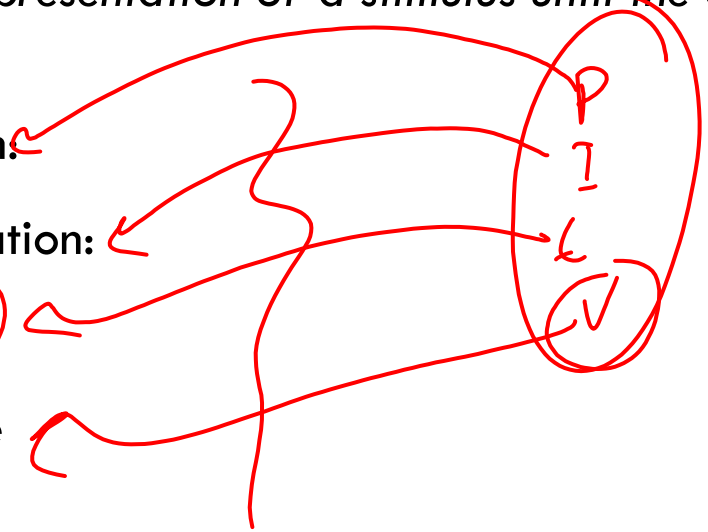
- good vision is prerequisite for safe driving
- visual acuity (alertness)
- color also affects vision
- depth perception

ii. Mental Characteristics (intelligence, experience, skills, etc.)

iii. Emotional characteristics (impatience, attentiveness, anger, etc.)

There are at least four steps or phases in information processing that occur from the presentation of a stimulus until the driver responds. (PIEV theory)

- Detection:
- Identification:
- Decision:
- Response



WALKING SPEED

Pedestrian walking speed range from about 0.8 to 1.8 m/sec.

- A pedestrian walking rate of 1.2m/sec is assumed for the timing of pedestrian traffic signals.
- Free flow walking speeds vary with the pedestrian's age and sex as well as trip purpose.
- Pedestrians carrying baggage tend to walk about as fast as those without baggage.
- Walking speeds decrease with the increases in pedestrian density.

VEHICULAR CHARACTERISTICS

1. Static characteristics
2. Dynamic characteristics
3. Vehicle kinematics

1.Static characteristics

Static characteristics include size and weight of vehicle

Under size

Length, width and height

Length

Length of vehicle will affect extra widening and minimum turning radius, passing sight distance,

road capacity and parking facility.

Width

width of vehicle will affect lane width, width of shoulders and width of parking spaces.

1.STATIC CHARACTERISTICS CONTD..

Height

height of vehicle affects clearance to be provided under structure bridge, electric service lines and tunnels

Weight

weight affects pavement thickness, requirement of ruling and limiting gradient and design of bridges.

Maximum Width, m	2.50
Maximum Height, m	4.75
Maximum Length, m	18.00
Maximum single axle load, kN	100

Source: NRS, 2070

2.DYNAMIC CHARACTERISTICS

- Dynamic characteristics of vehicle affecting road design are speed, acceleration and braking characteristics.
- Vehicle in motion has to overcome following resistance:

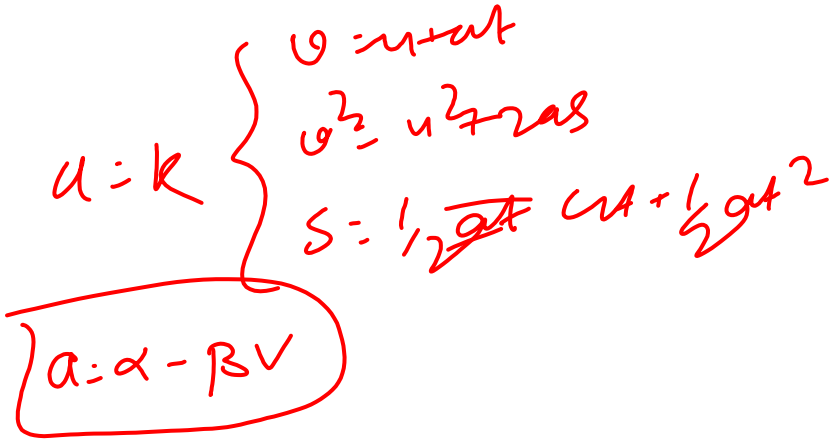
  -air resistance

  - rolling resistance

  - grade resistance

  - frictional resistance

  - internal resistance



- Some important vehicular characteristics are:

vehicle Power :

Power of the heaviest vehicle and its gross weight governs the permissible and limiting values of gradient on roads.

Speed of the vehicle:

affects sight distance, super elevation, length of transition curve, limiting radius on horizontal curve, width of pavement, capacity of traffic lane, and design and control measures on intersection.

TRAFFIC STUDIES

- Traffic studies provide data to analyze the characteristics of traffic and thus help in deciding the geometric elements and traffic control for safe and efficient traffic movement.

When the traffic is composed of a number of types of vehicles, it is the normal practice to convert the flow into equivalent passenger car unit (PCUs), by using certain equivalency factors.

- The flow is then expressed as PCU per day or PCU perhour.

- Types of traffic studies:

1. Traffic volume study
2. Speed Study:

a. Spot speed study b. Speed and Delay study

3. Origin and Destination Study
4. Traffic flow characteristics
5. Traffic Capacity study
6. Parking Study
7. Accident Study

TRAFFIC VOLUME STUDY

- Traffic volume is the number of the vehicles crossing a section of road per unit time at any selected period.
- Traffic volume is used as a quantity measure of traffic flow.
- Units – veh/hrs, veh/day, etc.

SN	Vehicle Type	Equivalency Factor
1.	Bicycle, Motorcycle	0.5
2.	Car, Auto Rickshaw, SUV, Light Van and Pick up	1
3.	Light (Mini) Truck, Tractor, Rickshaw	1.5
4.	Truck, Bus, Minibus, Tractor with trailer	3
5.	Non-motorized carts	6

Source: Nepal Road Standard, 2070

- However, the flow is expressed as PCU/hour of PCU/day for mixed traffic conditions.

TRAFFIC VOLUME STUDY CONTD….

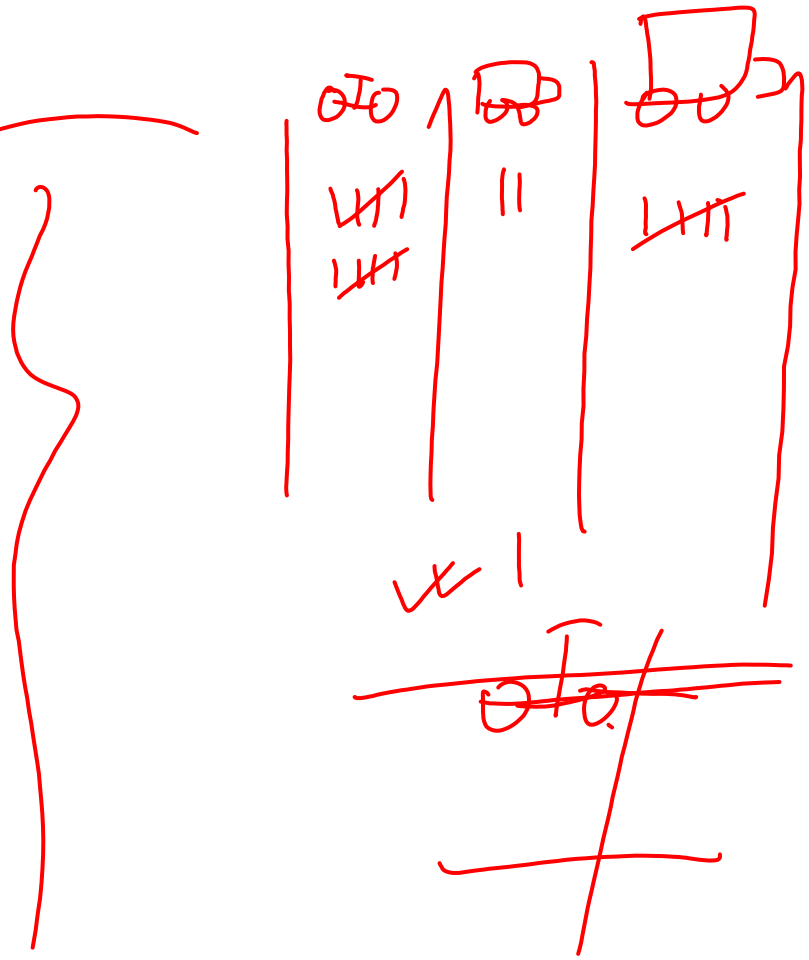
Methods of Traffic Counts

A) Manual count

B) Automatic devices

C) Observation method

D) Photographic Method.



TRAFFIC VOLUME STUDY CONTD....

Future Traffic Estimation

$$A = P(1+r)^n$$

Where,

A :number of vehicles per day for design

P : number of vehicles per day at the last census

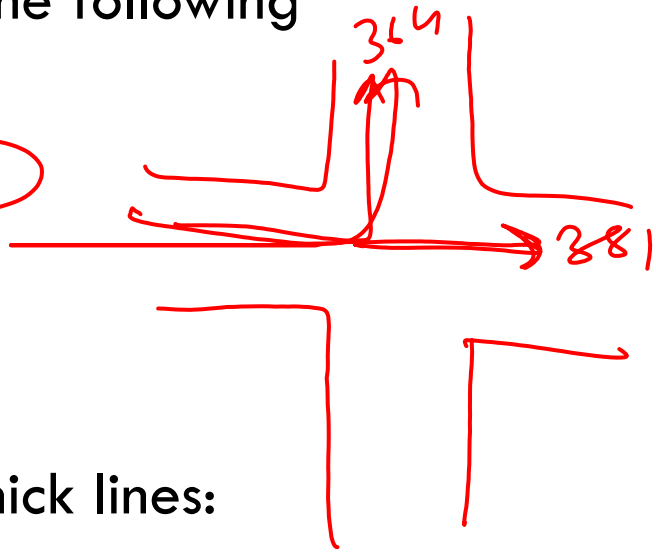
r :annual rate of increase in traffic (generally taken as 5%)

n: number of years between last census and years of consideration for design.

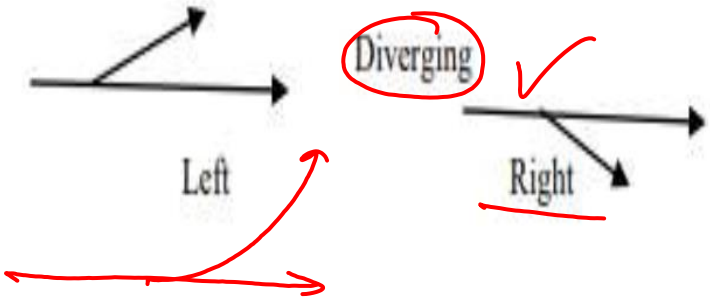
PRESENTATION AND ANALYSIS OF TRAFFIC VOLUME DATA:

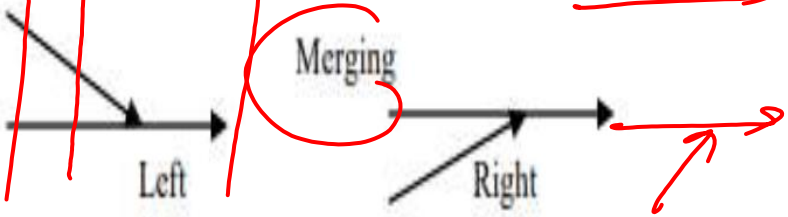
Data collected during the traffic volume study are sorted out and are presented in any of the following forms depending upon requirements:

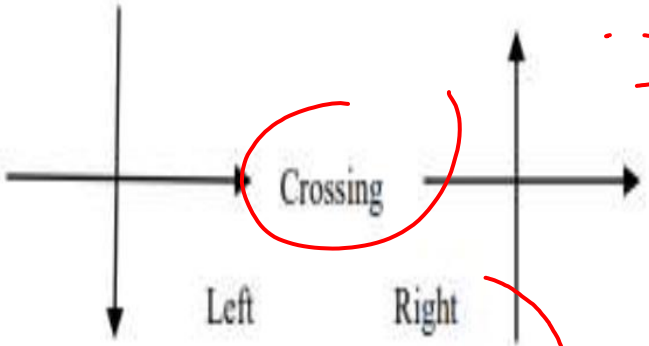
1) Average Annual Daily Traffic (AADT)
2) Trend Chart:
3) Variation Chart:
4) Traffic flow at intersection shown by thick lines:
5) Traffic Flow Maps

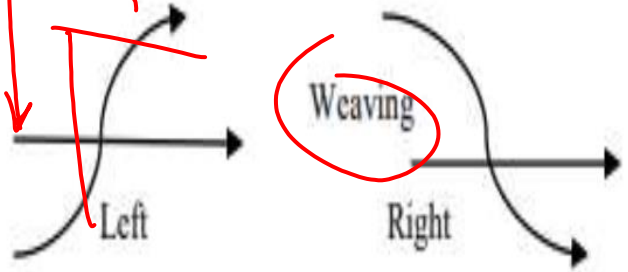


Traffic flow maneuvers







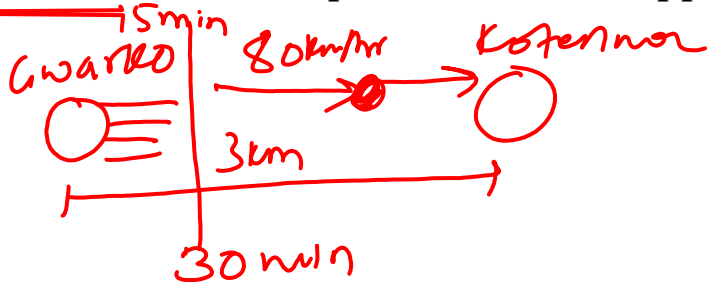


Traffic Speed Studies

TRAFFIC SPEED STUDIES CONTD…

Importance of speed studies

- Traffic operation like sign location and timings, establishing speed zones etc.
- Geometric design of elements like curvatures, super elevation, stopping sight distance etc.
- Determining speed trend.
- Crash studies.



Definition of terms:

1. **Spot speed**:

✓Instantaneous speed of the vehicle as it passes a specified point on the highway.

✓Spot speed is affected by physical of road like pavement width, curve, sight distance and grade.

TRAFFIC SPEED STUDIES CONTD…

2. Average speed:

✓ average spot speed of several vehicles passing a specific section is termed as average speed.

There are two types of average speed: Space mean speed and time mean speed.

a.Space Mean Speed:

- Average speed of vehicles over a certain length of road at a given time.
- It is determined from the observed travel time of the vehicles over a relatively long stretch of the road.
- It is simply the distance travelled divided by average travel times.

Space mean speed (Vs)

$$v_s = \frac{L}{\sum_{i=1}^{n} \frac{t_i}{n}} = \frac{nL}{\sum_{i=1}^{n} t_i}$$

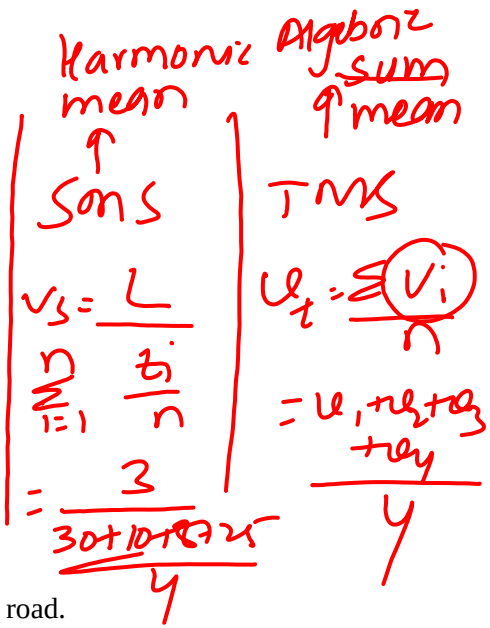
Where,

n - Number of individual vehicle observation

L- Length of the road section(m)

ti - observed travel time in (sec) for the i th vehicle to travel L m.

It is the harmonic mean of speeds observed at a point



TRAFFIC SPEED STUDIES CONTD…

a.Space Mean Speed:

$$v_s = \frac{n}{\sum \frac{1}{v_i}} \text{ or } v_s = \frac{n}{\sum \frac{f_i}{v_i}}$$

b. Time Mean Speed:

Average speed at a point over a period of time.

It is the arithmetic mean of the speeds observed at a point.

It represents the speed distribution of vehicles at a point on the road.

$$v_t = \frac{\sum v_i}{n}$$

Vt is time mean speed (km/h)

Vi observed instantaneous speed of the i th vehicle kmph

n no of vehicles observed.

$$v_t = \frac{\sum f_i v_i}{\sum f_i}$$

TRAFFIC SPEED STUDIES CONTD…..

Variance

$$V_t = V_s + \frac{\sigma_s^2}{v_s}$$

Shows that, the TMS is always greater than the SMS.

$$V_s = V_t - \frac{\sigma_t^2}{v_t}$$

$$\sigma_s{}^2 = \frac{\sum(v_i - v_s)^2}{n-1}$$

$$\sigma_t{}^2 = \frac{\sum(v_i - v_t)^2}{n-1}$$

TRAFFIC SPEED STUDIES CONTD.....

$v_t = \frac{20+40+60}{3} = 40$

$\frac{n}{v_s} = \frac{1}{v_1} + \frac{1}{v_2} + \frac{1}{v_3}$ SMS

$v_s = \frac{n = sf}{\sum_{i=1}^{n} f_i / v_i}$ TMS

a) 40

b) 36

c) 32.77 kmph

d) 10

$\frac{3}{v_s} = \frac{1}{20} + \frac{1}{40} + \frac{1}{60}$

$v_s = 32.78$ km/hr

Example 3

Three cars with speed 20kmph, 40kmph and 60kmph travelling length D. Determine the space mean speed and time mean speed.

Origin And Destination Study (O & D)

ORIGIN AND DESTINATION STUDY (O & D)

Definitions:

- In a transportation study, it is often necessary to know the exact origin and destination of the trips.
- Origin is defined as the place where the trip begins and destination is defined as the place where the trip ends.
- Origin and destination survey provides the basic data for determining the desired direction of flow.

Carried out O & D study for

- Determine the pattern of the journeys that people make.
- Determine the amount of travel there are between various locations.

ORIGIN AND DESTINATION STUDY (O & D)

Purpose of the Study is to get information about

- Why people travel - Purpose of the trip
- When people travel – Time and Direction
- How the people travel – Mode of travel
- Where do people travel – Origin and Destination
- Where and why people stop – To determine concentration of vehicles warranting need of parking facilities.

ORIGIN AND DESTINATION STUDY (O & D STUDY)

Methods

#Roadside Interview Method,

Registration Number Method,

#Tag or Sticker Method,

#Return Post Card / or Mail Return Method,

Home Interview Method

Commercial Vehicle survey

Taxi Survey

- Generally information recorded are :

(a) Survey station no.
(b) Date and hour,
(c) Vehicle type, and direction of travel,
(d) No. of passengers,
(e) Origin & destination
(f) Purpose of the trip

ORIGIN AND DESTINATION STUDY (O & D)

Methods of O-D Survey

1. **Road side interview method**

- Decide stations, take help of Traffic Police
- Stop vehicle and fill the prescribed questionnaire on the spot.
- Information : place & time of O - D ; route location, stoppages, purpose, vehicle and number of passengers.
- This is quick method, but it may cause the delay for traffic flow and it needs sufficient space to stop vehicles & take interviews.

ORIGIN AND DESTIN STUDY (O & D)

Methods of O-D Survey

2. License Plate Method

✓ Registration numbers of the vehicles entering or leaving the area are recorded at the station setup for the purpose

✓The observers with synchronized watches records the passes time and vehicle registration number as the vehicle passes the observer

✓Vehicle's origin is assumed to be where it was first observed while its destination is assumed to be its last observation point

✓ Large number of stations are required to take observation so as to get the information of the routes followed by the vehicles hence large number of study personnel is required to take simultaneous observations.

ORIGIN AND DESTINATION STUDY (O & D)

Methods of O-D Survey

3.Return post card method

- ✓Road users are distributed post cards on which the questionnaire to be filled in, along with the request to answer them and also the purpose of study is printed
- ✓Cards may be directly mailed to the vehicle owners or distributed through such stations where vehicles have to stop

ORIGIN AND DESTINATION STUDY (O & D)

Methods of O-D Survey

4.Tag on car method car method

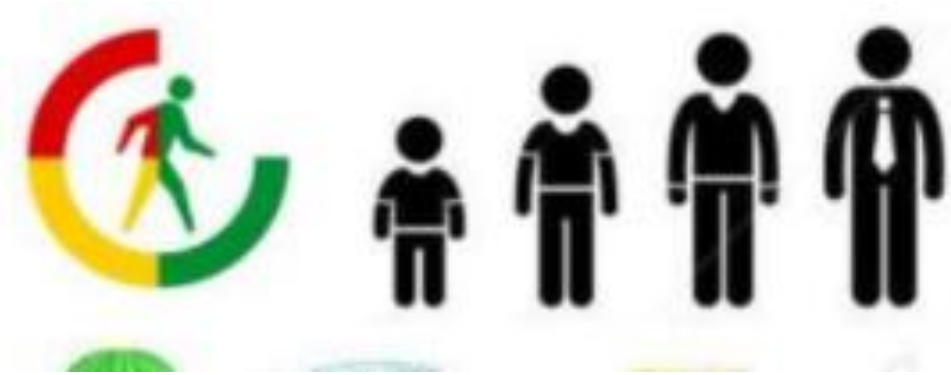
- Pre-coded cards are tied to the vehicles at observation station when it enters the study area
- The tag is removed from the car as soon as it leaves the cordoned area
- On the removed card, the time of entry, time of leaving, station, direction of travel, etc. are marked.

ORIGIN AND DESTINATION STUDY (O & D)

Methods of O-D Survey

5. Home interview method:

- O.5 to 10 % of the household is randomly selected for the home interview survey.
- Specific questionnaire is designed for the interview.
- Travel relate ected.



ACCIDENT STUDIES

3E
Engineering
Enforcement
Education

4E
Emergency Response

Accident Prevention

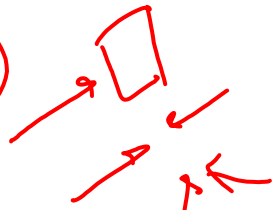
3 Es :

1.Engineering

2. Enforcement

3.Education

Imp?



1. Engineering measures

- road design
- preventive maintenance of vehicles
- before and after studies
- road lighting

Objectives of Accident Studies:

(1) To study the cause of accident

(2) To evaluate the existing design

(3) To support proposed design

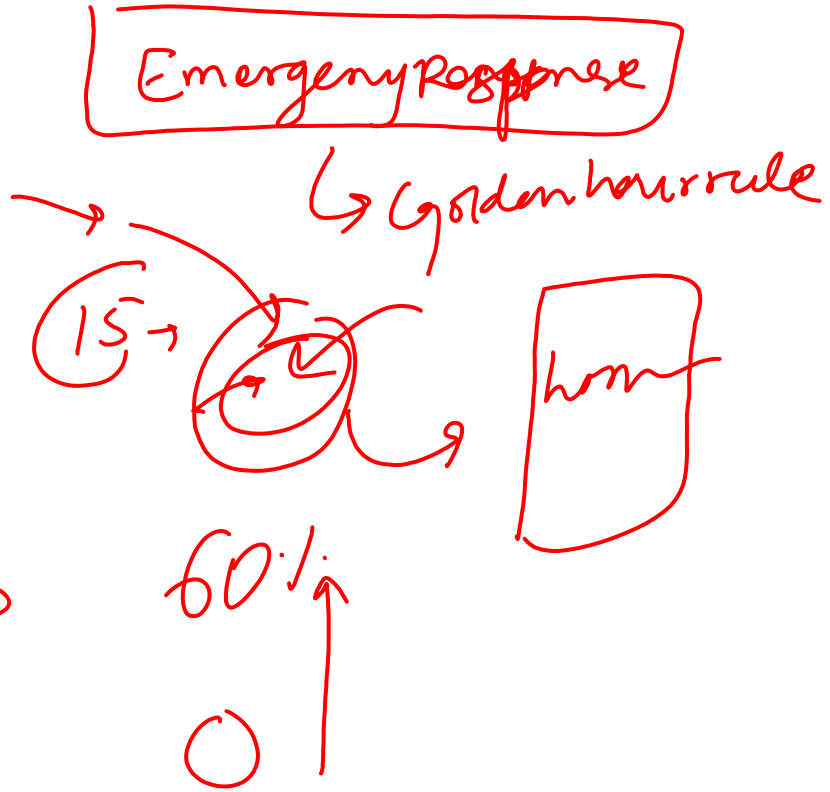
(4) For computation of financial loss

(5) For giving economic justification

ACCIDENT STUDIES

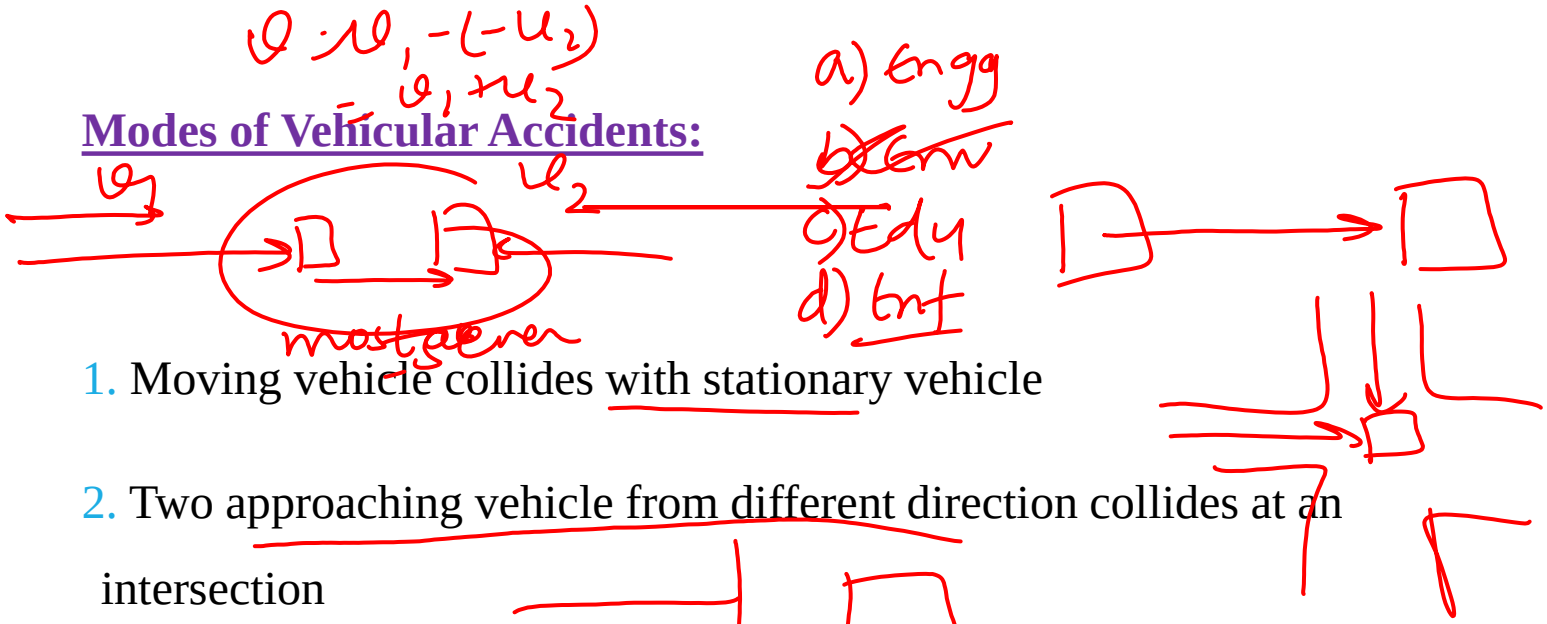
Accident Prevention

2. **Enforcement measures**
   - speed control
   - traffic control devices
   - training and supervision
   - medical check
   - observation of law and regulation
3. **Educational measures**
   - education for road users
   - safety drive



ACCIDENT STUDIES

Modes of Vehicular Accidents:



1. Moving vehicle collides with stationary vehicle

2. Two approaching vehicle from different direction collides at an intersection

3. Head and collision of vehicle apposing from opposite direction

4. Moving vehicle collides with stationary object like tree, electric pole, parapet or other rigid structures

SYMBOLS USED IN ACCIDENT DIAGRAMS

Table 8-3 Symbols Used in Accident Diagrams

Symbol used	Interpretation	Symbol used	Interpretation
Vehicle-type symbols		**Accident-type symbols**	
	Passenger car		
(T)	Truck		Rear-end
(B)	Bus		Head-on
(C)	Cycle		Right angle
(O)	Other		
	Pedestrian		Other angle (opposing dire
Movement symbols			
	Left turn		Other Angle (common direc
	Right turn		Sideswipe (common direc
	Straight		
Severity symbols			Sideswipe (opposing dire
	PDO		
	Injury		Out-of-control
	Fatal		Collision with fixed object

PARKING STUDIES

- Parking is the act of stopping a vehicle and leaving it in unoccupied for more than a brief time
- Parking is one of the serious problems that confront the urban planner and the traffic engineer

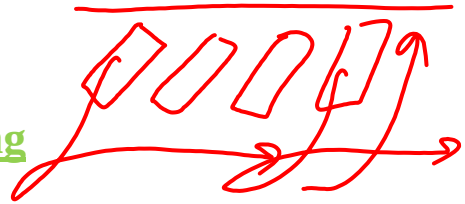
- **Objectives of Parking Study**

  - to determine congestion in the city or town area.
  - to assess parking demand
  - to decide capacity, location and types of future parking facility
  - to estimate the desire and demands of public for parking facility

PARKING STUDIES

Parking Categories

1. On-Street Parking



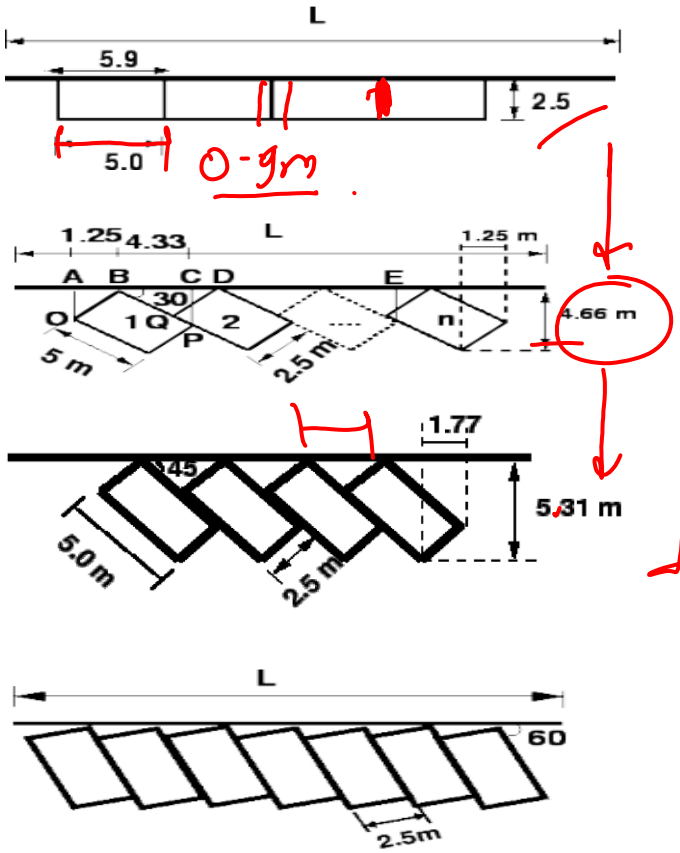
❖On street parking means the vehicles are parked on the sides of the road itself

❖It consumes the maximum kerb length and therefore only a minimum number of vehicles can be parked for a given kerb length

❖Parallel parking where the width of kerb parking space and width of street is limited.

❖Angle parking : 30/45/60/90 degree angle parking. 45 degree is considered suitable from all prospects.

ON-STREET PARKING CONTD…



$$\text{Number of vehicle} = \frac{L}{5.9}$$

$$\text{Number of vehicle} = \frac{L - 1.25}{5}$$

$$\text{Number of vehicle} = \frac{L - 1.77}{3.54}$$

$$\text{Number of vehicle} = \frac{L - 2.17}{2.89}$$

PARKING STUDIES

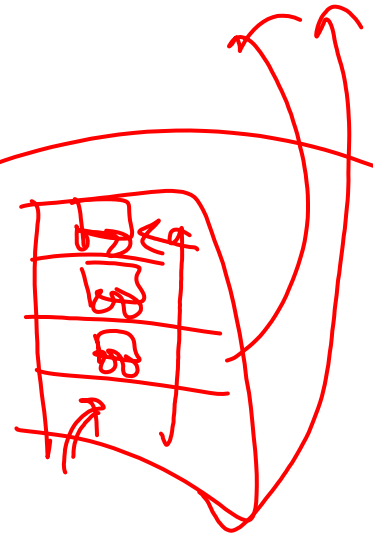
2. Off-Street Parking

- In many urban centers, some areas are exclusively allotted for parking which will be at some distance away from the main stream of traffic. Such a parking is referred to as off-street parking.

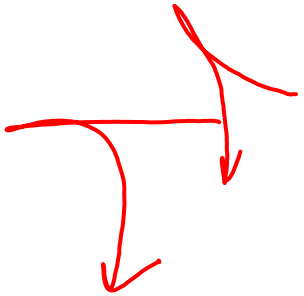
- No congestion and delay on roads as in on-street parking.

Types of off street parking

1. Surface car parking
2. Multistorey Parking
3. Roof Parking
4. Mechanical parking
5. Underground parking



SOME FACTS



- Maximum vehicles can be parked at 90 degree
- Drivers prefer to park at 75 degree
- Most economical parking is 45 degree.
- Parallel parking are preferred when the width of the road is limited

Ill effects of parking

(1) Congestion

(2) Accident

(3) Obstruction to Emergency Vehicles

(4) Environmental Pollution

ROAD INTERSECTIONS

- Intersection is an area shared by two or more roads
- Road intersection can be defined as the general area where two or more roads join or cross within which are included the road way and road side facilities for traffic movement in that area.
- Its main function is to guide vehicles to their respective directions
- Intersections are points of traffic hazards which affect safety, speed, efficiency, capacity and cost of operation of the whole road

Basic Requirements of Intersection:

(1) There should be adequate visibility for all the approaching roads.

(2) Relative speed of approaching vehicles should be kept small.

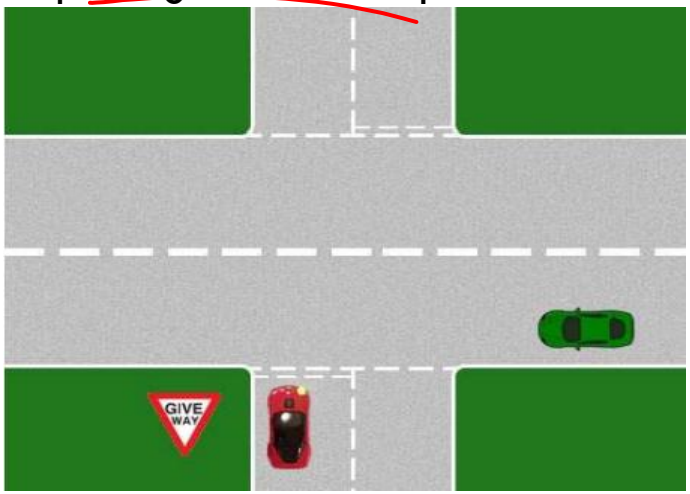
(3) Sudden change of path should be avoided.

(4) Width of pavement at radius for turning should be sufficient enough

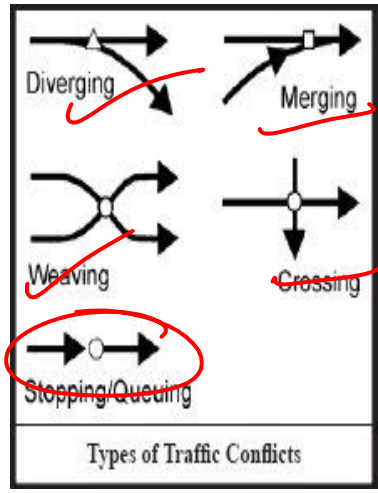
(5) Area of conflict should be reduced to minimum by designing traffic island and channelizing island.

(6) Good lighting at night is required.

(7) Proper sign should be provided on the road.

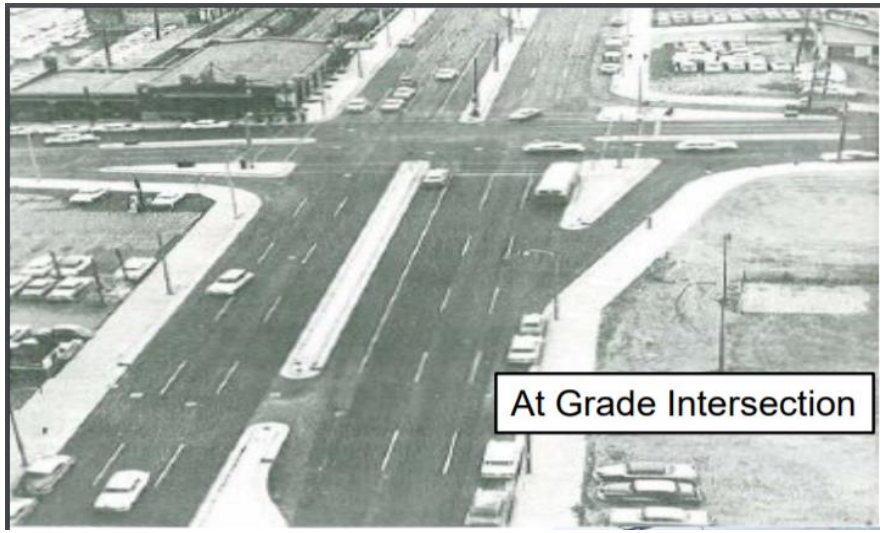


TYPE OF INTERSECTION AND THEIR CONFIGURATION:



A. Intersection at grade or level :

- When two or more roads/highways/streets meet at grade, with each road
- All the approaching or converging roads meet at one level
- Traffic maneuvers include merging, diverging, crossing and weaving
- Legs should be met at right angles or not less than 60-70 degree



TYPE OF INTERSECTION AND THEIR

CONFIGURATION:

B. Unchannelized Intersection:

- An unchannelized intersection is one without island for directing traffic into definite path
- Heavy flow of traffic leads to frequent crashes and the intersection cannot perform properly
- Cheapest, easiest in design but complex in traffic operation
- Resulting in maximum conflict area and more number of accidents, unless controlled by traffic signals or police

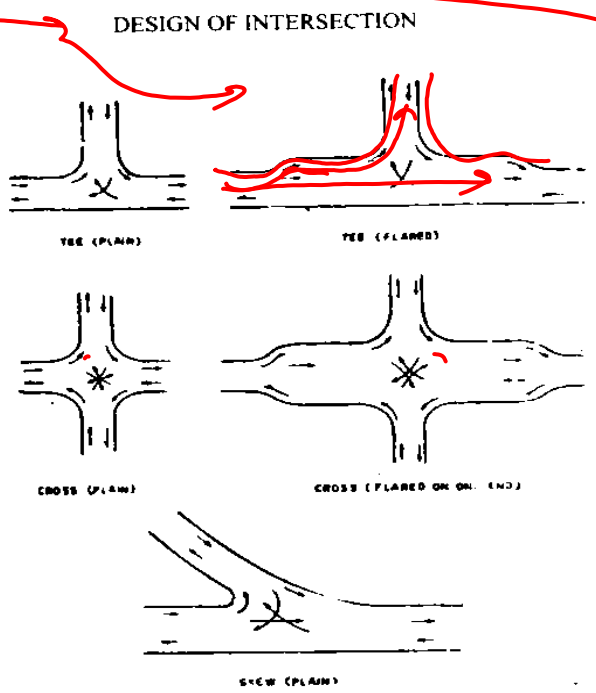


Fig. 5.34 Unchannelized Intersections

TYPE OF INTERSECTION AND THEIR CONFIGURATION:

D. Rotary Intersection

- A rotary intersection or traffic rotary is an enlarged road intersection where all converging vehicles are forced to move round a large central island in one direction (clockwise direction) before they can weave out of traffic flow into their respective directions radiating from the central island.

- The main objectives of providing a rotary are to eliminate the necessity of stopping even for crossing streams of vehicles of the vehicles

- Rotaries and roundabouts are channelized intersections comprising a central circle surrounded by a one-way roadway

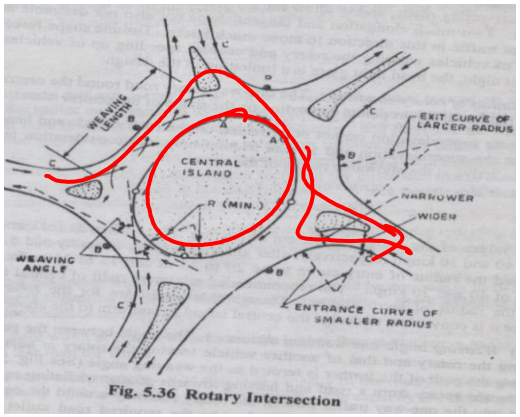
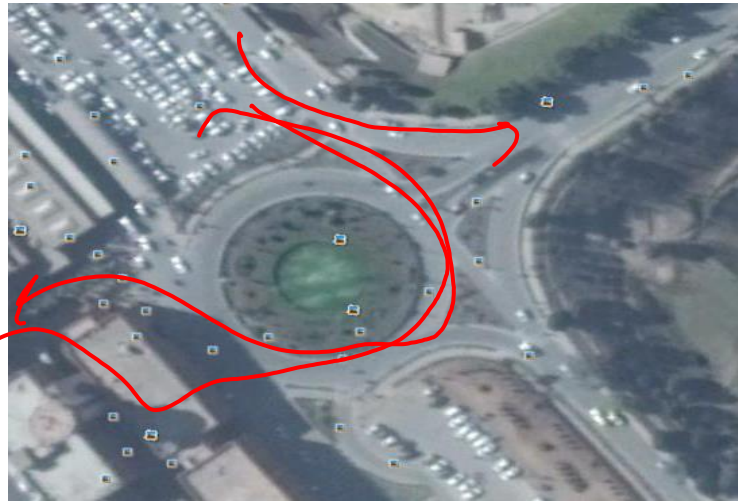


Fig. 5.36 Rotary Intersection

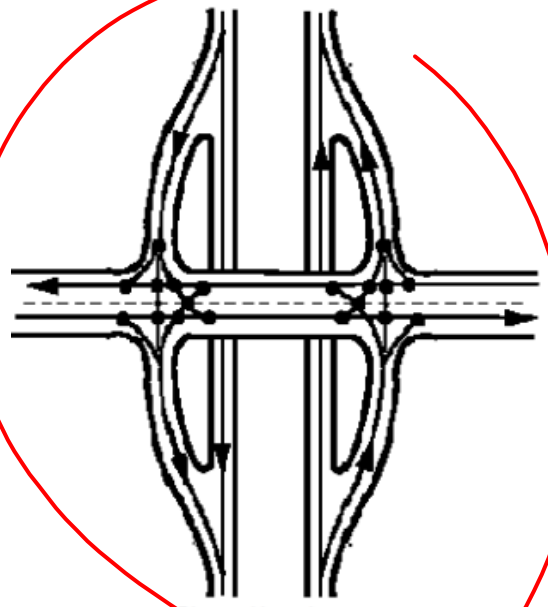


TYPE OF INTERSECTION AND THEIR CONFIGURATION

E. Grade Separated Intersection Contd….

Diamond interchange

- A popular form of interchange in urban locations involving a major-minor crossing is a diamond interchange
- It can be designed for a relatively narrow right of way of the major road.



Diamond interchange

TRAFFIC CONTROL DEVICES

- Traffic control devices are the media by which traffic engineers communicate with drivers and road users
- Traffic control devices are placed in key locations to guide and regulate traffic movement, control vehicle speeds, and warn of potentially hazardous conditions
- Traffic control devices also provide important information to users about traffic delays
- Virtually every traffic law regulation or operating instruction must be communicated through the use of devices that fall into four broad categories:

1. Traffic sign
2. Traffic signals
3. Traffic markings
4. Traffic Island

TRAFFIC CONTROL DEVICES

1. **Traffic sign:**

- Measure to convey specific information to the driver quite in advance, so that he/she may become careful
- The three main functions of traffic signs are to regulate, warn and inform
- Sign should be placed such that they could be seen and recognized by the road users easily and in time
- Location is about 0.5m away from kerb edge
- On roads without kerb the nearest edge may be 2m to 3m from the edge of carriage way
- Sign post painted with 25cm black and white bands

TRAFFIC CONTROL DEVICES

1. Traffic sign Contd:

- There is a different group of signs for each function, and the signs in each group have a uniform shape to help drivers recognize them quickly

- The three groups are:

I. Regulatory Signs

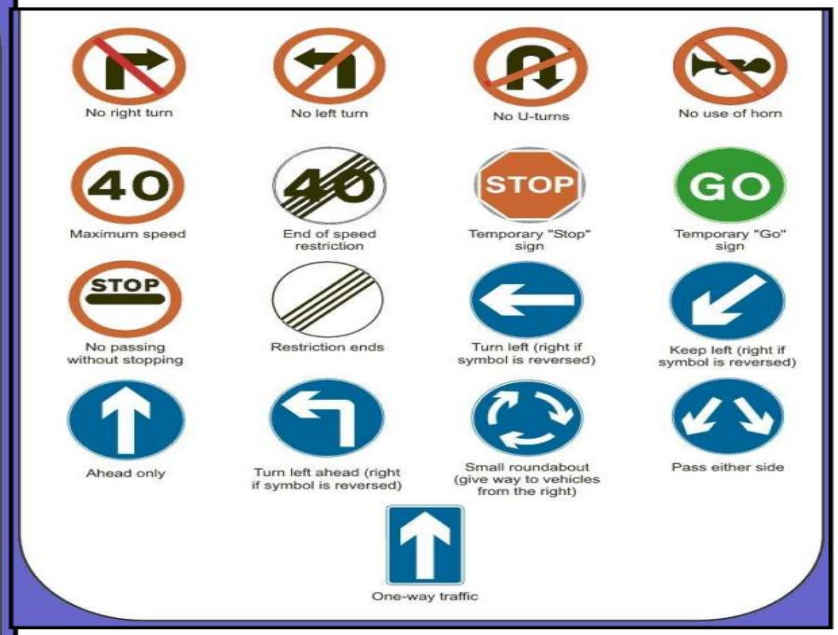
II. Warning Signs

III. Information Signs

TRAFFIC CONTROL DEVICES

I. Regulatory Signs Contd :

- Traffic Sign Manual (Published by DOR) schedule of regulatory signs (A1 – A33) thirty three types of signs



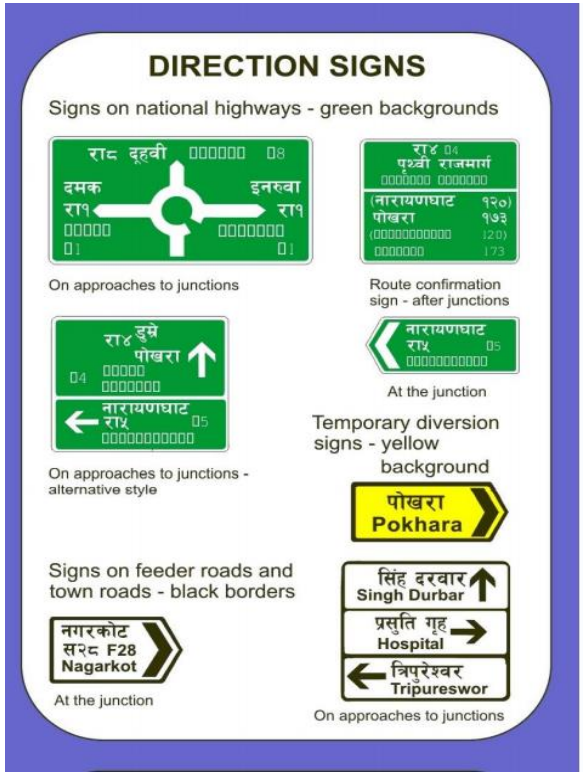
TRAFFIC CONTROL DEVICES

II. Warning Signs Contd:

The Traffic Sign manual describes about 48 warning signs (B 01 – B 48)

TRAFFIC CONTROL DEVICES

III. Information Signs Contd:



TRAFFIC CONTROL DEVICES

2. Traffic signals:

- Traffic signals are such control devices which can alternately direct the traffic to stop and proceed at level intersections
- The main requirements of traffic signals are to draw attention, provide meaning and time to response and to have minimum waste of time
- The primary purpose of a traffic signal installation at a road junction is to reduce conflict between traffic streams

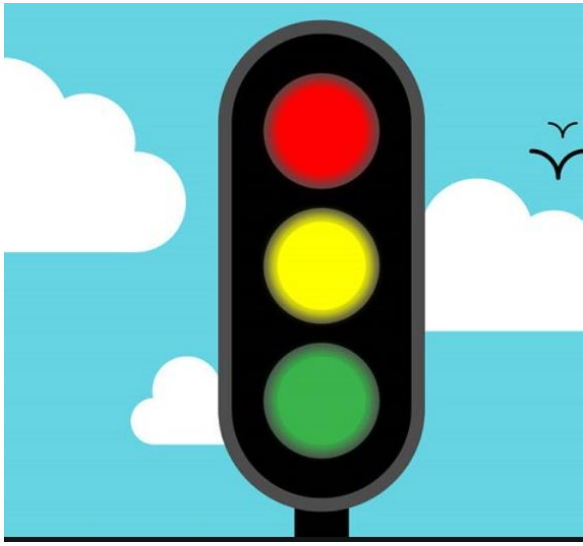
TRAFFIC CONTROL DEVICES

2. Traffic signals contd:

Advantages of Traffic Signals

- Traffic handling capacity of the intersection is increased
- Right angled collision points are reduced
- Traffic signals when subjected to automatic control prove more economical than manually operated signals
- Pedestrian can cross the roads safely at the signalized intersection
- Signals provide chance to crossing traffic of minor road to cross the path of continuous flow of traffic stream

TRAFFIC CONTROL DEVICES



Types of Traffic Signals

Traffic light signals

This group of signs comprise of two categories:

- Signs for the control vehicles
- Signs for the control of pedestrian crossing movement

Signs for the control vehicles

- **Red Light** :Traffic is prohibited from proceeding beyond the stop line
- **Green Light:** Vehicular traffic may proceed beyond the stop line
- **Amber Light** : Conveys same prohibited as red signals except where vehicles are so close to the stop line that they cannot safely stop before the stop line they should proceed

DESIGN OF TRAFFIC ROTARY

❖ Radius of Central Island

$$R = \frac{V^2}{127 * f}$$

- f = 0.43 and 0.47 for speeds 40 kmph and 30 kmph respectively
- Minimum radius of central island should be greater than 1.33 times radius of entry curve

❖ Width of weaving

Where e_1 is the width of the carriageway at the entry and e_2 is the carriageway width at exit.

$$W_{weaving} = \left(\frac{e_1 + e_2}{2}\right) + 3.5m$$

❖ Weaving angle and length

- ✓ Small weaving angle but should not be less than 15degree.
- ✓ Weaving length at least 4 times the width of the weaving section.
- ✓ Minimum Recommended weaving length 45-90 m for 40 kmph 30-60 m for 30 kmph

DESIGN OF TRAFFIC ROTARY

❖ Entrance and Exit Curves

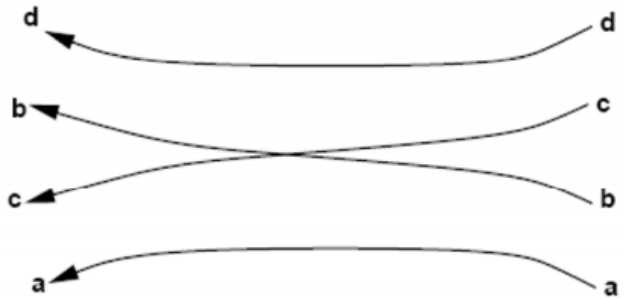
- For 40 kmph entry curve radius 20 – 35 m
- For 30 kmph entry curve radius 15 – 25 m
- Exit curves should be of a larger radius than entry curves, usually 1.5 to 2 times of radius of entry curve is considered reasonable

❖ Capacity of Rotary Roadway

$$Q_p = \frac{280W(1 + e/w)(1 - p/3)}{(1 + W/L)}$$

Proportion of weaving traffic is given by

$$p = \frac{b + c}{a + b + c + d}$$



1. If there are two wheels on one side of the axle, then it must be converted into
   a) EWL
   b) ESL
   c) ESWL
   d) EL

ESWL stands for equivalent single wheel load. It is used to represent the load when more than one wheel is present in one side of the axle. The equivalent of both wheel loads is represented as ESWL.

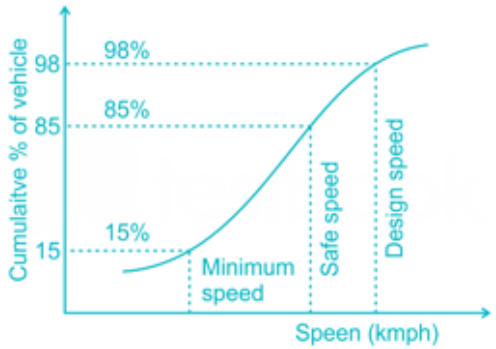
1. Which of the following is regulatory traffic sign?
a. Parking place (informatory)
b. Road narrow on both sides (warning)
c. Stop and Give way sign
d. None of these

1. The pedestrian may cross the road with care in
a. Red Standing Man
b. Green Walking Man
c. None
d. All of these

1. 'Give Way' is regulatory traffic sign with …….. shape.
a. Triangular
b. Circular
c. Octagonal
d. Rectangular

1. …… percentile speed is provided as safe speed limit in road.
a. 98^{th}
b. 85^{th}
c. 75^{th}
d. 25^{th}

The **98th percentile speed** is adopted for **geometric design of highway.**



Geometrical design speed = 98^{th} percentile speed

Safe speed limit = 85^{th} percentile speed

1. The average 24hrs traffic volume on weekdays over a full years is
a. AADT
b. AAWT
c. ADT
d. AWT

1. The ill effects of parking is
a. Congestion
b. Crash
c. Obstruction to the emergency vehicles
d. All of the above

1. Which of the following is ‘On street parking’ ?
a. Multi-storey parking
b. Underground parking
c. Kerb parking
d. None of above

1. Time mean speed (TMS) is ……. Space mean speed(SMS)
a. Slightly less than
b. Never less than
c. Never greater than
d. Equal to

$$V_t = V_s + \frac{\sigma_s^2}{v_s}$$

Shows that, the TMS is always greater than the SMS.

$$V_s = V_t - \frac{\sigma_t^2}{v_t}$$

1. The clearance time is indicated by
   a. Red
   b. Green
   c. Amber
   d. White

2. The number of vehicles crossing a section of road in a unit time at any selected period is called
   a. Traffic volume study
   b. Traffic density study
   c. Traffic mass study
   d. Traffic characteristic study

3. The instrument used to study ‘spot speed’ in traffic engineering is
   a. speedometer
   b. speed recorder
   c. enoscope
   d. enometer

1. The number of vehicles occupying a unit length of roadway at given instant is:
a. Traffic density
b. Traffic volume
c. Traffic capacity
d. Passenger car unit

1. The best type of angle parking is
a. 30°
b. 45°
c. 60°
d. 90°

1. Maximum number of vehicles can be parked with
   a. 30° angle parking
   b. 45° angle parking
   c. 90° angle parking
   d. parallel parking

1. The maximum number of vehicles beyond which rotary intersection is not effective from
a. 500 PCU/hr
b. 2000 PCU/hr
c. 5000 PCU/hr
d. 5000 PCU/day

1. If space mean speed of a vehicle is 50kmph, then the time mean speed will be
   a. Less than 50kmph
   b. Greater than 50kmph
   c. Equal to 50kmph
   d. Depends on the vehicle

VISIBILITY

❖Good visibility enables the motorist (and pedestrian) to quickly discern significant details of the roadway

❖ **Some factors that directly influence visibility are:**

- The brightness of an object on or near the roadway
- The size of objects and identifying details
- The contrast between an object and its surroundings

REQUIREMENTS OF LEVEL OF ILLUMINATION IN ROAD

- Distribution should be downwards
- It should produce maximum uniformity of pavement brightness
- It should cover the adjacent area 3 to 5 m beyond the pavement edge
- For main highways 30 lux
- For main roads 15 lux
- And for secondary roads 4 to 8 lux

DESIGN OF LIGHTENING SYSTEM

Design factors:

1. Lamps types and selection:

- Types
- Size
- Color

Type of Lamp	Initial Light Output lumes x 10^3
Incandescent	0.6 - 15
Clear Mercury	3.7 - 57
Phosphor-coated Mercury	4.0 - 63
Metal Halide	34 - 100
High Pressure Sodium	9.5 - 140
Low Pressure Sodium	1.8 - 33

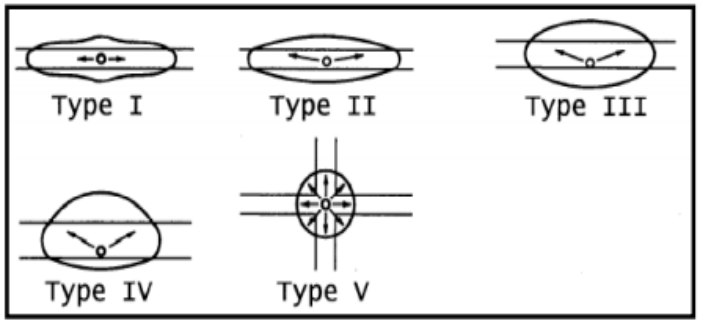
- Economical to use largest lamp size in a luminaire to provide uniform brightness
- Luminance- candela/sqm- how bright the roadway is
- Illuminance- in lux- the amount of light incident on road

DESIGN OF LIGHTENING SYSTEM

Design factors Contd:

2. Luminous distribution of light:

- Proper distribution of light
- Downward- high % of light is utilized for illuminating the pavement area
- Kerb + area 3 to 5 m beyond pavement edge
- 20 to 30 lux= average lux- in urban area
- 15 lux- other main road
- 4 to 8 lux- secondary roads
- Indian code- average 30 lux



DESIGN OF LIGHTENING SYSTEM

Design factors Contd:

3. Spacing of light units:

- The distance between successive lighting units measured along the centerline of the roadway
- In general spacing should be 35 to 45 m and should not exceed 55 m
- Spacing may be determined by the quality of illumination needed on different street
- The wider the spacing of lanterns, the lower the level of light

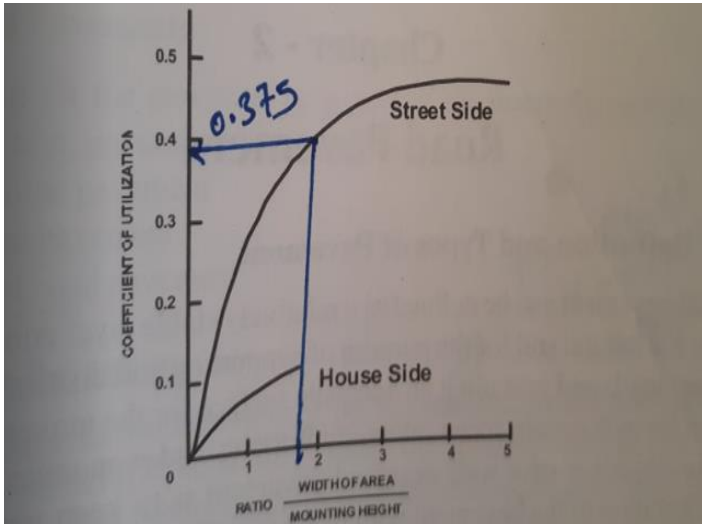
DESIGN OF LIGHTENING SYSTEM

Design factors Contd:

3. Spacing of light units:

$$Spacing = \frac{Lamp\ Lumen * Coefficient\ of\ Utilization * Maintenance\ Factor}{Average\ Lux * Width\ of\ Road}$$

Where, Maintenance factor usually taken as 80%



DESIGN OF LIGHTENING SYSTEM

Design factors Contd:

4. Height and overhang mounting:

- The vertical distance between the roadway surface and the center of the apparent light source of the luminaire
- The distance the lamp is mounted above the roadway will affect the illumination intensity, uniformity of brightness, area covered, and relative glare of the unit
- Higher mounted units will provide greater coverage, more uniformity, and reduction of glare
- The height of luminaires above the roadway surface varies from 15 feet to more than 100 feet
- Conventional roadway lighting utilized mounting height of 25 to 50 feet

DESIGN OF LIGHTENING SYSTEM

Design factors Contd:

5. Lateral placement:

- Horizontal distance from the edge of pavement
- Street lighting poles should not be installed close to the pavement edge
- IRC recommendations for roads with raised kerbs: min 0.3 m and desirable 0.6 m from the edge of raised kerb
- For roads without raised kerbs: minimum 1.5 m from the edge of the carriageway