

Unit - 01

Traffic engineering Road Traffic characteristics

Traffic engineering -

Traffic engineering is a branch of highway engineering which deals with the improvement of traffic performance of the road network and terminals. It includes planning, geometric design, regulation and control.

→ California university defines traffic engineering, it is the science of measuring traffic & travel. The study of basic laws relative to traffic flow and generation and application of this knowledge to professional practice of planning, design and operating traffic system to achieve safe and efficient movement of people and goods.

Objective of Traffic Engineering -

The basic objectives of traffic engineering are -

- 1) To achieve efficient, free and rapid flow of traffic with least no. of traffic accidents or casualties.
- 2) Factual studies of traffic operation and provide the foundation for developing method improving in solving specific type of problem in traffic.
- 3) Necessary to give increasing alterations to the operational characteristics of highway transportation.
- 4) Required to study the need for better geometric design, capacity, intersections, traffic sign and signals, Roadway markings, parking facilities etc.

Scope of Traffic Engineering

Traffic Engineering



- Traffic characteristic
- Traffic operation, control & Regulatory
- Planning & Analysis
- Traffic studies & Analysis
- Geometric Design
- Administration & management
- Measure for operation traffic

Relationship between Speed, volume & Density in traffic -

The fundamental relationship between traffic volume, density and speed may be given by general equation of traffic flow -

$$q = v_s k$$

q = The average volume of vehicles passing a point during a sp. period of time
Unit $\Rightarrow$ (vehicle / hour)

k = The average density or no. of vehicles occupying (unit length) unit length of road way at a given instant (time)

Unit $\rightarrow$ vehicle per km.

V_s = Space mean speed of vehicle in a unit length of road way (km/h.)

Note :

With increase in speed of vehicle in a unit length of road way the average density decreases there is because the spacing between the vehicles is increasing with the

Density (k) vehicle/km

Volume (q) vehicle/hour

Speed (V) km/h

$$q = k \cdot V$$

17 Traffic Characteristic :-

- a) Road user characteristic
- b) vehicle characteristic ✓
- c) Road characteristic

Q Road user characteristic -

The human element is involved in all action of the road user either as pedestrian, cyclist, driver or motorist. The physical, mental and emotional characteristic of human being affect their ability to operate motor vehicle safely or to service as a pedestrian.

→ Hence it is important for the traffic engineers to study the characteristic & limitation of road user.

→ The factor affecting road user characteristic may be classified as -

- I> Physical
- II> Mental
- III> Emotional
- IV> Environmental

→ Physical characteristics —

The physical characteristics of a road user may be temporary or permanent. It includes vision, hearing, strength and general reaction.

→ Vision includes activity, peripheral vision, eye movement, colour vision, colour necessary and depth judgement. A minimum standard is laid down by the licensing authority. These factors are particularly taken into account while designing and installing traffic control devices.

→ Hearing is more necessary for pedestrian and cyclist.

The reaction time of traffic situation depends on the time required to perceive and understand the traffic situation and then take appropriate action.

II> Mental characteristic —

Knowledge, skill, intelligent experience and literacy can affect the road user characteristic.

Psychology of the road user will be quite useful for safe traffic operation. Reaction to certain traffic situation become more spontaneous (स्वतः) with experience. Understanding the traffic regulation and special instruction and timely taking action depends on intelligence and literacy.

III> Emotional characteristic —

(स्वतः) The emotional factors such as fear, anger, superstition, impression, attentiveness, general attitude to road traffic rules and regulation.

→ Distraction by non traffic events and various worries (चिन्ता) reduce attentiveness to traffic situation.

IV> Environmental characteristics —

The various environmental conditions affecting the behavior of road user are traffic stream characteristics, facilities to traffic, atmospheric condition and locality.

→ The adaptability to different traffic stream depends on driver characteristic. The time, place and route are fundamentally chosen by the driver based on the needs.

Q3) * Vehicular characteristics :-

Vehicular characteristics affect the design and traffic performance. The main aim of highway engineering is to fulfill the needs of existing and anticipated (भविष्य) traffic. Hence, the vehicle standard should be uniform atleast within the country.

→ Some of the main vehicular characteristics are :-

a) Vehicle dimension : The dimensions to be mainly considered are overall width, height & length of the vehicle. A vehicle then represent the design standards are known as design vehicle. The design data includes axle load, axle spacing, wheel

base etc.

→ The vehicle dimension are specified by IRC with consistency with existing road facilities.

Maximum dimension of road vehicle :-

Dimension of vehicle	Details	maximum dimension [excluding foot & spare wheel] in metre
1. Width	All vehicle (more than 2 wheel)	2.50 m.
2. Height	(a) Single decked vehicle for normal application.	3.80 m.
	(b) Double decked vehicle	4.75 m.
3. Length	(a) Single unit truck with two or more axle.	11 m.
	(b) Single unit bus with two or more axle.	12 m.
	(c) Semi trailer tractor combination	16 m.
	(d) Tractor and trailer combination	18 m.

b) Weight of vehiculars —

The maximum weight of vehicle affects the design of pavement (रेखा शरदा विराम चले से) thickness and gradient (slope) as per IRC. The maximum permissible single axle load should not exceed 8165 kg. The gross load of any vehicle should not exceed the weight given by the following formula.

$$W = 465(24 + 3.28L) - 14.6L^2$$

where,

W = The Gross weight of vehicle in kg.

L = The distance in metre between extreme axles

c) Speed of vehiculars —

The vehicular speed affects —

⇒ HZ and ut alignment design.

⇒ Super elevation
sight distance.

- Limiting radius
- Grades
- Skid resistance

d) Efficiency of Brakes — When brakes are applied and if it's efficiency is 100% then the wheels are assumed to be fully ~~lagged~~ locked.

Efficiency of grade depend on the design & type of breaking system.

3) Road characteristic :-

(a) Gradient — Gradient is the ^{rate} of rise or fall along the length of road with respect to the HZ. It is expressed as a ratio of 1 in x (where 1 is unit unit and x is HZ unit)

Sometimes it is also expressed in percentage. They are of following types :-

- Rolling Gradient
- Limiting Gradient
- Exceptional Gradient
- Minimum Gradient

(b) Curve of Road -

1) Horizontal Curve - A curve that is provided to change the direction on plan into the central line of road is known as horizontal curve.

2) Vertical curve -

Due to change in grade in the alignment of highway it is necessary to introduce a curve of intersection of different grades to smoothen out the vertical profile and thus ease off the change in gradient for fast moving vehicle.

(c) Design speed -

The design speed is the main factor on which geometric design elements depend.

The design speed of roads depends upon the class of road and its terrain (जमीन का पैटर्न).

For national and state highway of our country passing through plain terrain is 120 km/hr. and through rolling is 80 kmph.

Reaction time —

→ Perception Time

→ Brake Reactⁿ time

Reaction time of the driver is the time taken from the instant (उसी समय) the object is visible to the driver to the instant when the brakes are effectively applied.

The amount of time gap depends on many factors. During this time the vehicle travels some distance at original speed or design speed.

The stopping distance increases with increase in reaction time of the driver.

→ The total reaction time is divided into two parts

- 1) Perception time
- 2) Brake Reactⁿ time

1) Perception time — The perception time is the time required for a driver to realize that brake must be applied.

It is the time from the instant the object comes on the line of sight of the driver to the instant he realizes that the vehicle must be stopped.

→ The perception time is varying (बढ़ती वही) and depends upon several factors such as speed, distance of object, environmental condition etc.

Q) Break reaction time —

12/10/23 The time required in the application of break is known as break reaction time.

★ ★

PTEV Theory :-

According to this theory the total reaction time of the driver is divided into 4 parts :

P — Perception

I — Intellation

E — Emotion

V — Volition

P — Perception Time :-

It is the time required for the sensations received by the eyes, ear etc. to be transmitted to the brain through nervous system and spinal cord —

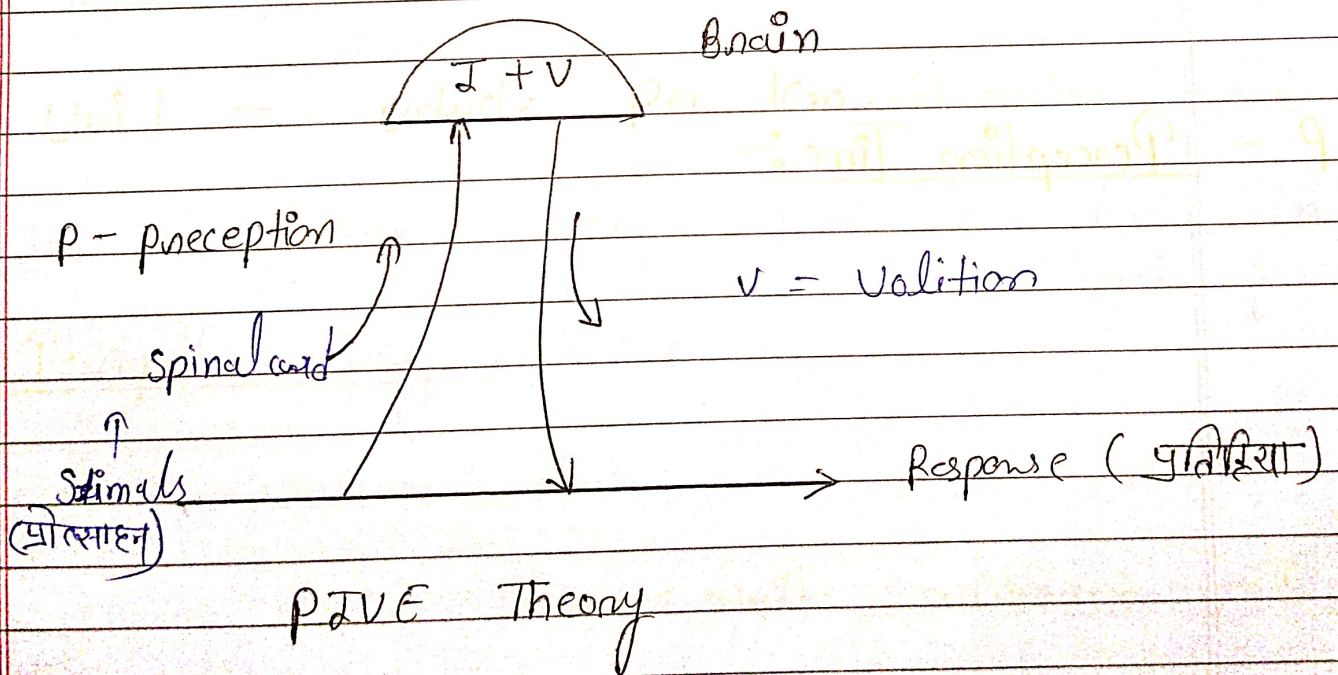
→ It is the time required to perceive an object or a situation.

I - Intellection Time :- It is the time required for understanding the situation. It is also the time required for composing diffⁿ thought and registering new ideas in response (प्रतिक्रिया) to the situation. (Use time)

E - Emotion Time :- It is the time lapsed during emotional sensation and disturbances such as fear, anger or superstition (अंधविश्वास) with respect to the situation.

These for emotion time of a driver depends on the problem.

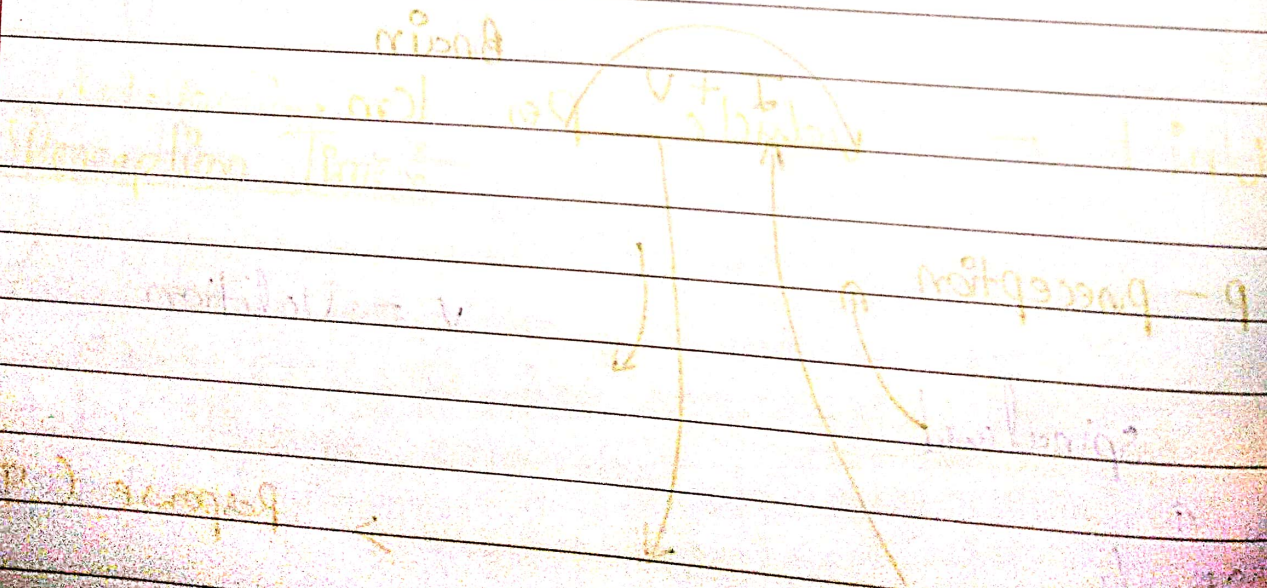
V - Volition Time :- It is the time taken for final action.



The PIVE PIEV time of the driver depends upon many factors such as physical & psychological characteristics of the driver, type of problem, environmental factors, travel speed etc.

→ The Total reaction time of on average driver may vary from 0.5 sec to 3-4 sec.

~~seen~~
~~12/10/23~~



Traffic StudiesTraffic Studies -

Traffic studies & service are carried out to analysis the traffic characteristics. These studies help in deciding the geometric design, features and traffic control for safe and efficient traffic movement.

Traffic Volume studies - This is a basic traffic studies which involves counting the no. of vehicle passing a given point on the road.

Traffic volume - Traffic volume is defined as the no. of vehicles crossing a section of road per unit time at any selected period.

Object and Purpose of Traffic volume

- These studies is useful to establish relative importance of any route and road facility.
- Traffic volume study is used in research planning, designing and regulation phase of designing.

- IT helps in establishing priorities and schedules for traffic improvement.
- IT helps in structural design of roads.
- IT is also used in carrying out economics studies.
- IT helps in planning & design of new streets and facilities.

Methods of Traffic Volume Counting

Traffic volume counts can be done by following method —

- 1) Manual Counting
- 2) Photo. Automatic Counting
 - a) photoelectric method (light - curtain)
 - b) pneumatic method
 - c) electric method
- 3) Moving Car method.

1. Manual Counting — As per IRC in order to estimate traffic count the observer records the traffic volume, vehicle classification, turning movements etc.

This method includes a field team to record traffic volume on the prescribed sheets. In this method it is not practicable to have manual counts for all 24 hours of the day and on all the days.

ground the year.

→ But still is the most reliable and best method to obtain classified volume and directional volume for short counts.

2. Automatic Counters —

Types fixed or They are of two portable.

→ In case of photoelectric cell method the automatic counter is actuated (start) the interruption of light beam following the photoelectric cell place in the road side as the vehicles pass through it.

→ In electric method the counter is actuated by the closing of an electric circuit by the passage of vehicle.

→ In the pneumatic method the counter is actuated by the air which attach the to a flexible hose stretched across the road over which the vehicle passage.

→ The data collected by automatic counters are not as accurate as manual method. Since to use more method going together are recorded as single unit.

→ These count should be supplemented by manual short count to check their accuracy of working on to evolve directional & classified count by sampling techniques.

3. Moving Car method —

This method consist of counting no. of vehicle meeting, overtaken and the time taken to travel by the observer once moving against the traffic & once along the traffic.

Presentation of Traffic volume Data %

→ The Indian Road Congress recommended that the count should be taken for full week at a time spread over 7 consecutive days and 24 hours during each day.

→ Counts are taken atleast twice every year, one count being taken during the peak season of harvesting in marketing and the other during lean season.

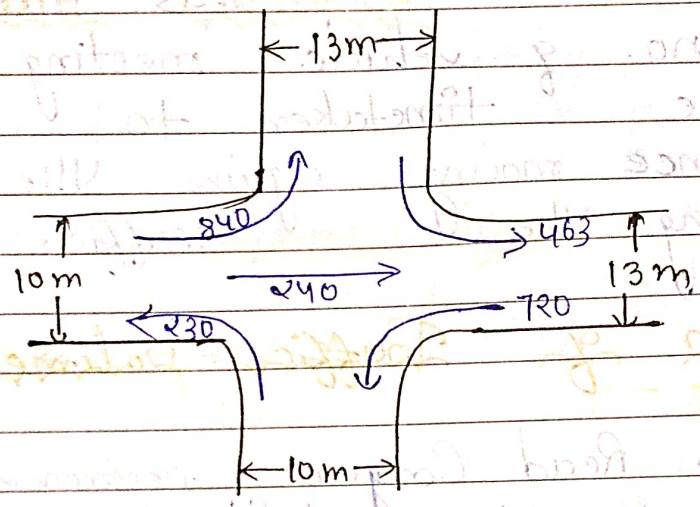
→ These counts should not be done in abnormal condition of traffic like fair or exhibition.

→ As per IRC the daily traffic summary compiled from the field data sheet should indicate the peak and traffic in the days for fast and slow vehicles.

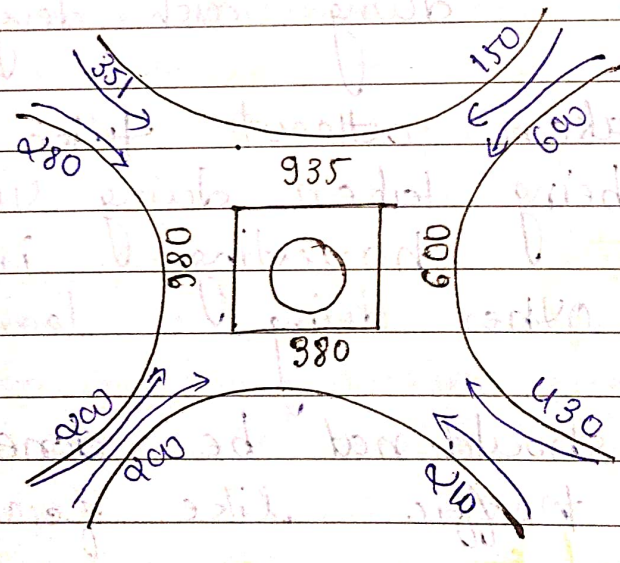
→ After 7 days of survey is Over, information sheet in daily Summary should be transfer to the weekly traffic summary form.

Presentation of Distribution

Intersection →



Rotary →



Speed Studies :-

Actual speed of the vehicle over a particular road may vary depending on various factors such as geometric design, traffic, time etc.

Purpose of Conducting speed studies -

1. Determining speed trends.
2. planning traffic control measures such as traffic signals, location of warning, installing regulatory & informatory signs etc.
3. Accident studies. $S \propto \frac{1}{t}$

Travel time - It is the reciprocal of speed & is the simple measure of how well a road network is operating.

Spot speed - It is the instantaneous speed of a vehicle at a specified section or location.

Average speed - It is the average of the spot speed of all the vehicles passing a given point on the highway. There are two definitions of average speed.

1) Space mean speed :- space mean speed represents the average speed of vehicle in a certain road length at any time. It is obtained from the observed travel time of the vehicles over a relatively long stretch of road.

the road. It is calculated from -

$$V_s = \frac{3.6 d n}{\sum_{i=1}^n t_i}$$

empirical formula

where,

V_s = space mean speed kmph

d = length of road, considered, in m

n = number of individual vehicle observed

t_i = observed travel time (in sec) for i^{th} vehicle to travel distance d , m.

11) Time mean speed :- Time speed represents the speed distribution of vehicle at a point on the roadway and it is the average of instantaneous speeds of observed vehicles at the spot. It is calculated from -

$$V_t = \frac{\sum_{i=1}^n v_i}{n}$$

where, V_t = Time mean speed, kmph

v_i = observed instantaneous speed of i^{th} vehicle kmph.

* The space mean speed is slightly lower than time mean speed under typical speed conditions on rural highways.

Spat Speed Study —

for following aspects —

- To use in planning traffic control and regulation.
- To use in geometric design of new facilities or redesigning highways.
- To use in accident studies.
- To decide the speed limit.

Spat speed is determined by endoscope, graphical recorder, electronic meter, radar and by photographic method.

✓ Presentation of spat speed data :-

a) Average speed of vehicle :- From the spat speed data frequency distribution tables are prepared using the data in group covering various speed ranges - number of vehicles in such range.

b) Cumulative speed of vehicle :- A graph is plotted with the

Speed of the observed vehicles at the spot
Calculated from —

$$U_t = \frac{\sum_{i=1}^n u_i}{n}$$

where

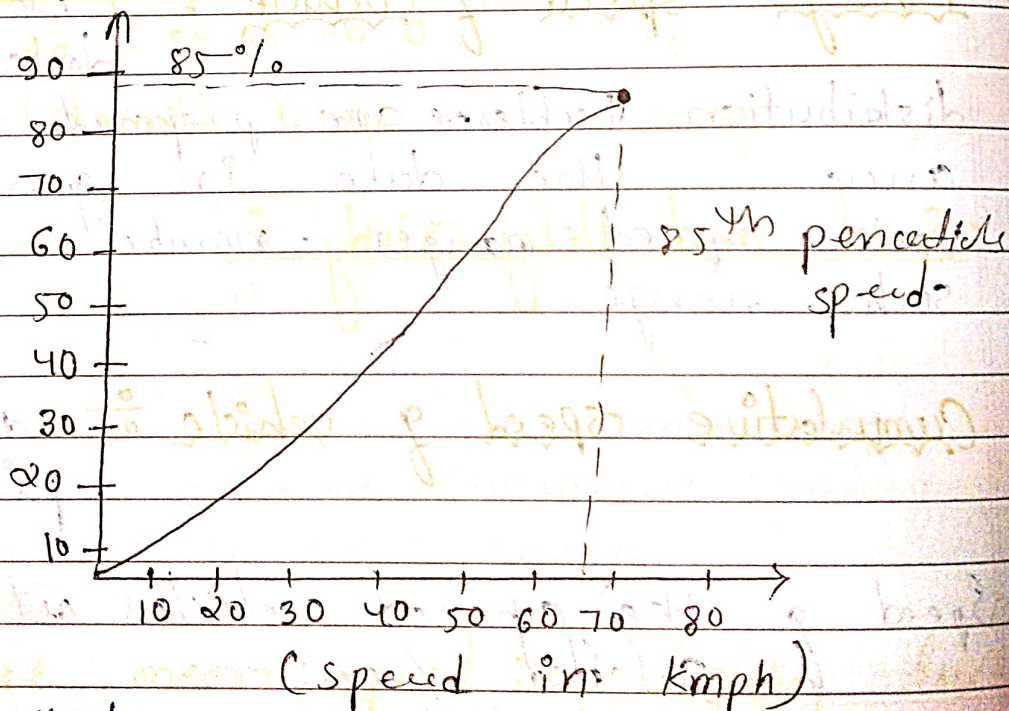
u_t = Time mean speed in kmph

c_i = Observed instantaneous speed of the i^{th} vehicle in kmph.

Note: The space mean speed is lower than the time mean speed under typical speed conditions on rural highway.

Spot Speed Study :-

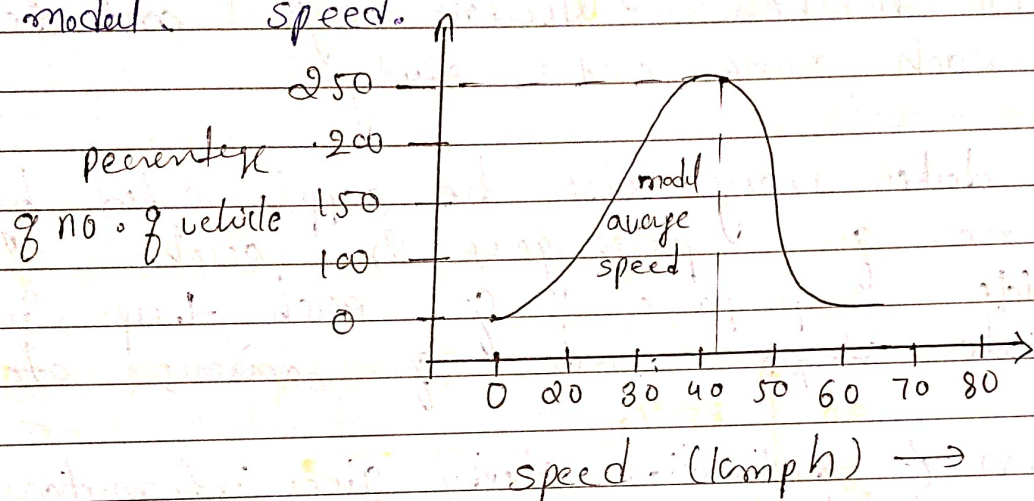
average value of each speed group on x-axis and cumulative percent of vehicles travelled at or below the def'n speed group on y-axis. From this graph the 85th percentile speed is found.



It gives that speed at or below 85% of the vehicles are passing the point on the highway or only 15% of the vehicles are exceeding speed at that point.

c) Model Average :-

A frequency distribution curve is plotted with speed of vehicles on x-axis & the percentage of vehicle in that range on y-axis. This graph is known as speed distribution curve. The speed at to vehicle move given by model speed. This curve while have a definite peak value of travel speed a cross the section and this speed is known as model speed.



Speed and Delay Study :-

The speed & delay study give the running speed overall speed, fluctuation in speed for apart.

→ They also as informatⁿ and cause of delay study are useful in detecting the spots of congestion (pts), the causes and it's remedial methods for a arising at a suitable location.

→ This study is also used for finding the travel time & benefit cost analysis.

Origin and Destination studies (O & D) :-

The origin and destination study is carried out mainly to (i) plan the road network & other facilities for vehicles traffic and

(ii) plan the schedule of diffⁿ modes of transport for the trip & demand of commuters.

→ The O & D studies of vehicular traffic determine their numbers & their origin and destination in each zone under study.

→ The data may also be supplemented by the no. of passengers in each vehicle & purpose of each trip, intermediate stops made & seasons etc.

→ Origin & destination study gives information like the actual direction of travel, section of roads and length of the trip.

→ These studies are most essential in planning new highway facilities and in improving form of the existing systems.

Applications :-

→ To judge the adequacy of existing roads and to used in planning new network of roads.

- To plan transportation system and mass transit facilities in including routes and schedules of operation.
- To locate expressway or major routes along the dense lines.
- To establish preferential routes for various category of vehicle including by pass.
- To locate terminals & to plan terminal facilities.
- To locate new bridge as per traffic demands.
- To locate intermediate stops of public transport.
- To establish design standards for the road, bridge and culverts along the route.

Methods of O & D Studies :-

1) Road Side Interview method - The vehicles are stopped at previously decided interview station, by a group of persons and the are to prescribed questionaire are collected on the spot.

- The information collected include the p' & time of origin and destination, route, location of stoppages, the purpose of the trip, type of vehicle & numbers of passengers in each vehicle.

- In this method the data is collected quickly in short duration. and the field organization is simple and the team can be trained quickly.
- The main drawback of the method is that the vehicles are stopped for interview, and there is delay to the vehicles movement.
- Also resentment is likely from the road users.
- Further, unless there is enough space, undue congestion may result due to stopped vehicles.

2) License plate method —

- The entire area under study is cordoned off and the observers are simultaneously stationed at all points of entry and exit on all the roads leading to and out of the area.
- Each party at the observation station is given synchronized time pieces and they note the license plate numbers (registered no) of the vehicle entering & leaving the cordoned area and the time.
- Separate recording sheets are maintained for each direction of movement for a specified time interval.

- This method is quite easy and quick as far as the field work is concerned.
- The field organisation can also be trained quickly.
- The method however involves a lot of office competencies in tracing the + through a net work of stations.
- Unless there is a large network of stations to take observation along the route of the vehicle it is not easy to get the information of the routes followed by the vehicles.
- Hence a large no. of teams are required to take simultaneous observations when a large area is to be surveyed.
- However, this method is quite advantages when the area under consideration is small, like a large intersection or a small business center.

3. Return Post Card method —

pre-paid business reply post cards with return address are distributed to the road users at some selected points along the route or the cards are mailed to the owners of vehicles.

- The questionnaire to be filled in the road user is printed on the card, along with a

request for co-operation and purpose of the study.

→ The distributing stations for the cards may be selected where vehicles have to stop as in case of a toll bar.

→ Only a part of the road users may return the cards promptly after filling in the desired details properly and correctly.

→ If conclusions are drawn in such cases, it is likely that these may not give a true picture.

4) Tag on Car method — In this method a pre-coded card is stuck on the vehicle as it enters the road under study.

→ When the car leaves the road near the other observations are recorded on the tag.

→ This method is useful when the traffic is heavy & moves continuously.

→ But the method gives only information regarding the point of entry & exit and the time.

time taken to traverse the area.

- 5-) Home Interview method — A random sample of 0.5% - 10% of the population is selected & the residents are visited by the trained personnel who collect the travel data from each member of the household.
- Detailed information regarding the trips made by the members is obtained on the spot.
 - The data collected may be useful either for planning the road net work & other roadway facilities for the vehicular traffic or for planning the mass transportation requirement of the passengers.
 - The problem of stopping vehicle & consequent difficulties of the passengers.
 - The problem of stopping vehicle and consequent difficulties.
 - The present travel needs are already known and the analysis is also simple.
 - The selection of the method is dependent in the objective and the location.
 - The influence of year and date of study on the type and amount of traffic.

demand should be known.

6) Work spot interviews method - The transport
needs of work trips can be planned by collecting the O & D data at work spots like the offices, factories, education institutions etc. by personal interviews.

presentation of O & D data

The data are present in the following forms,

1) Origin and destination tables are prepared showing members of trips b/w diffⁿ zones.

2) Desire lines are plotted which is a graphical representation prepared in almost all O & D surveys.

→ Desire lines are straight lines connecting the origin points with destinations, categorized into diffⁿ order groups.

→ The width of such desire lines is drawn proportionally to the no. of trips in both directions.

→ These desire lines may be compared with the existing flows pattern along the existing route by superimposing.

one over the other with the help of tracing sheets.

37 Contour lines may be plotted similar to topograph contours. The shape of the contours would indicate the general traffic need of the area.

Speed & Delay Study —

The delay or loss of time due to traffic during the travel period may be due to —

- a) fixed delay
- b) operational delay.

1) Fixed delay occurs at intersections, due to traffic signals & at level crossings.

11) Operational delay are caused by interference of traffic movement such as turning vehicles, parking vehicles, pedestrian.

→ Theor for the overall travel speed between the (start) origin & destination (fixed) points of travel is lower than the desired running speed.

→ The various method of for speed & delay study are 1, 2, 3.

floating Car or riding check method.

License plate or vehicle no. method.

Intercept to technique.

Evaluated Observation.

photographic technique.

Parking Studies

parking — placing of vehicles at proper place is known as parking.

Need of Parking —

- 1) With enormous increase in motor traffic, particularly cars the problem of parking is increasing in alarming proportion in large city.
- 2) Vehicles if improperly parked cause a lot of problem like : traffic congestions, accidents etc.
- 3) Marketing Centre, public places, location of government offices, Bank etc. are the places where shortage of parking is mostly experienced.

Parking studies —

The tremendous increase in the no. of vehicle of all type has created traffic & parking problems in almost all the major cities of India. The parking demand is likely to increase still further at a higher rate in the future. With this

increase, the present traditional method of parking along the ~~curve~~ kerb. will not be sufficient.

parking studies are necessary for the following reason :-

- 1) To obtain information regarding supply & demand of parking facilities.
 - 2) For development of plan for determining size, location, financing & construction and operation of motor vehicle terminal facilities.
 - 3) For improvement & regulation of existing parking facilities.
- Traffic studies as shown that the proper space control on parking by demarcating parking stalls optimises the utilization of available space for parking, reduce parking & un-parking time and increase the efficiency of the road & parking systems.

Moreover by scientific planning, regulation & control of parking the

no. of ~~accidents~~ accidents can be reduced.

Following aspects are investigated during parking studies —

- space inventory (available space)
- Cordon counts
- personal interviews
- parking practices
- parking characteristics

Ill Effects of parking —

- 1) Accidents
- 2) Congestion
- 3) Obstruction to emergency condition like:
fire fighting operation, ambulance service
etc.
- 4) Environment