The Road User and the Vehicle

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Transport Engineering

Traffic engineering

(Human Factor’s Governing)

Road user behaviour :

Broadly considered as two groups

1. Physiological
	1. Vision
	2. Hearing
2. Psychological
	1. Perception
	2. Intellection
	3. Emotion
	4. Volition

**Vision:**

Vision is most one or the important factor. The Human eye is the sensory organ that enables one to see.

* Evaluate the size, shape and color of objects.
* Estimate distance and speed of bodies.
1. Acute vison (sharp extremely):

Formed by a cone whose angle is 3o about Centre of retina. However, vision is till satisfactory when angle of cone is 10o or 12o. This is important locating traffic signs and signals.

1. Peripheral Vision:

The angle of peripheral vision is about 160o in the horizontal 115o in the vertical direction. If detailed attention of the eye is needed driver has to turns his head so that the object now comes within the cone of clear vision.

1. Color vision:

It is important for having the traffic lights and color schemes in traffic signs. But color blindness need not be of serious concern.

1. Driver eye should adopt to glare due to head-lights or to variations in the lighting conditions is an important factor.

Glare recovery time varies from 3 to 6 seconds.

 **Hearing:**

Hearing should be of service to the road -user. The sound of horn or the sound of the hearing vehicle itself can alert a pedestrian to safety. He has to design, operate, traffic facilities which will be useful.

**PIEV theory or PIEV time:**

Time taken for the process of perception, intellection, emotion and volition called it as PEIV time.

Perception:

Perception is the process of perceiving the sensations received through the eyes, ear’s, nervous system and the brain. The exact time required for this dependent upon the individuals psychological and physiological build-up

 Intellection:

Intellection is the identification of the event by the development of new thoughts of idea’s may form leading to better understand of the event.

 Emotion:

Emotion is the personal trait of the individual that governs this decision-making process, after perception and intellection of the event.

 Volition: volition is the will to react a situation.

 Total PIEV time is **2.5** sec.

**Vehicular characteristics:**

1. **Dimension and weight**:

Dimension and operating of a vehicle influence the geometric design aspects such as radii, width of pavement, clearness, parking geometric etc. The weight of the axels and the weight of the vehicle affect the structural design of pavement and structures. Because of its crucial important. The standardization of the dimension and weight of design vehicle is the first step in formulating geometric design standards

1. **Braking system:**

Breaks are need to bring the vehicle to a safe stop whenever a immediate danger. So safe stopping distance is composed of the distance travelled by the vehicle during the perception and brake reaction time and the distance required to stop the vehicle after the brakes are applied if *f* is coefficient friction between tyre and pavement.

1. **Acceleration and Deceleration:**

Acceleration characteristics of a vehicle need to be understood when designing te intellection element and overtaking sight distance. Acceleration rate is governed by the vehicle transmission system weight and horsepower. It is also changed with speed, being high at lower speeds and low at higher speeds.

 Medium passenger cars : 3-8 KPH/second

 Trucks and buses : 1-4 KPH/second

(when driver applies the brakes, vehicle decelerates)

Only in an emergency does the driver attempt to fully utilize the maximum deceleration. The maximum deceleration related to coefficient friction between tyre and the pavement.

Force required to deceleration a vehicle is

 **F = md**

m = mass of the vehicle

d = deceleration in m/sec2 = F/m

but *f =* F/mg

 m = $\frac{F}{fg}$

therefore, d = *f.*g = 9.81*f*

1. **Vehicle lighting system:**
* Lighting system of the vehicle consist of head lights, dipper beam, side lamps, parking lights, rear lights, direction indicator’s and stop lamps. An efficient and reliable system of lighting the vehicle is desirable for averting accidents.
* The headlight should perform 2 functions to provide main beam for the driver to see the road for sufficient long distance and to provide a dipper beam.
* Rear lamps give indication to the driver following a vehicle about the presence of a vehicle in front of him.
* Direction indication give adequate notice of the intension of the driver to turn or stop direct indications are usually amber in color and preferably they should be mounted at the side of the vehicle approximate at the level of the driver eye.

**Features of vehicular body:**

Factors needed to be considered are

1. The shape and dimension of the driver’s seat
2. Arrangement of dials on the dash board
3. Positioning of controls in relation to the driver’s seat
4. Visibility of the drivers from the seat
5. Noise levels in the vehicle
6. Concentration of carbon monoxide inside the vehicle.

(high horse power, proper secure locks to door’s)

**Tyres:**

* The performance of tyres relative to puncture, blowouts, vulnerability to damage by sharp objects, braking and road surface characteristics are areas where considerable research has taken place because of safety.
* Skidding is a phenomenon which is governed by the interaction of the tyre, brakes, road surface, speed and the wetness of road surface.
* It has extreme important in traffic accident prevention.

**Power Performance of Vehicles:**

* It is necessary to determine the vehicle costs and the geometric design elements.

**Resistance to motion of a vehicle:**

* Power developed by (vehicle) engine (Pp) should be sufficient to overcome all resistance to motion at the desires speed and to accelerate at any desired rate to desired speed.

**Rolling resistance:**

* When the vehicle wheels roll over the road surface the irregularities and the roughness of the surface cause deformation of the tyres road surface itself may undergoes deform. So rolling resistance varies with the type of surface

Rolling resistance to friction

Pf = m *f* g

 m = mass of vehicle in kg

 *f* = coefficient of rolling resistance

Pf  = rolling resistance in N

 g =acceleration due to gravity m/sec2

**Air resistance:**

* Air has density, it exerts a reaction pressure against the front of the vehicle when it moves at speed.
* The friction of the air against the sides of the vehicle body causes the resistance.
* Eddying of the air stream behind the vehicle, under the body and around causes power loss.
* The flow of air through the vehicle for ventilating and cooling causes resistance to motion.

Pa = Ca AV2

V = Speed of the vehicle relative to air m/sec

Ca = Coefficients of air resistance

A = Projected front area of the vehicle in sq.m on a plane at right angles to the tyre of motion

Pa = Air resistance N

**Grade resistance (Pi) :**

* when vehicle moving up an incline, an additional work has to be done in keeping the vehicle at the same speed.
* The additions work is equal to the works that will be needed to lift the vehicle through a height respectively by the vehicle.

+ Pi = mg/100

-ve represent reduction in the force to move the vehicle .

**Inertia forces during acceleration and deceleration:**

when the speed of moving vehicle needs to be increased some additional power is needed to accelerate. Similarly if the vehicle has to gather a desired speed from a stopped position addition force is needed to accelerate.

 Additional force Pj = Mass . acceleration

 +Pj = ma

**Transmission:**

Low speed high gear transmission losses high.

Losses in power occur to the mode of power transmission from the engine to the gear system. The vehicle has system of gear such that the speed of the vehicle can be altered relative to the engine speed at the start of the vehicle as well as while climbing uptill we need high engine power movement along good road where the resistance to motion will be small.

The highest forward will generally 1:1

# Speed, Journey Time and Delay surveys

**Spot speed** : Instantaneous speed at a specified location.

**Running speed** : Average speed by a vehicle over a given course while vehicle in motion.

**Journey speed** : Also Overall travel speed; is the effect speed of a vehicle between 2 points.

**Time mean speed**: Average of speed measurement at 1 point in space over a period of time. i.e., average of number of spot speed measure.

**Space mean speed:** average of speed measurement at an instant of time over a space.

Uses of speed, journey time and delay those vehicles are time any:

1. Spot speed:
	1. For geometric design of roads: design speed.
	2. Regulation and control of traffic operation: Traffic signal design required specified data.
	3. For analysis, the causes of accidents and identify any relation between speed and accidents.
	4. Before and after road improvement schemes it is necessary to have spot speed data.
	5. Determine problem of congestion.
2. Journey speed and Delay speed:
3. Cost of journey depends upon the speed. In all economic studies journey speed and delay are highly important.
4. To determine travel time to carry out the trip assignment. Also travel time and delay are some of the factors affecting modal choice.
5. Before and after studies.
6. Delay studies of intersection provide data for the design and installation of appropriate traffic control device.

Methods of measuring spot speed:

1. (req. observation of the) time taken by a vehicle to cover a known distance.
	1. Those vehicles are timed over a long distance
	2. Direct timing procedure:
		* Accurate stop watch as a vehicle crosses these 2 marks.
		* Known distance and measured time interval speed are calculated.
		* Skilled observed can read stop watch to an accuracy 0.2 second.
		* Disadvantage is large errors are likely to be happened because of the parallax effect.

Advanced method: 2 observers. One at the vehicle pass first signals that a vehicle to be timed is passing the point. Second observed starts the stop watch and stops watch when same vehicle passes terminal. Disadvantage is reaction time of two individual observers.

* 1. Enoscope:
		+ Also, called Mirror-box.
		+ It eliminates parallax error when direct readings are taken by one observer.
		+ Mirror box is L shaped box.
		+ Method can be done 1 Enoscope or 2 Enoscopes.
		+ If one Enoscope is used it is directly placed opposite the first reference point and observer at another reference point.
		+ Stop watch start as soon as vehicle passes the first reference point and stopped as soon as it passes the observer.
		+ If 2 Enoscopes are used observer station will be midway between 2 reference points.
	2. Pressure contact tube:
		+ Detectors are used. (pneumatic tube) to indicate time entering and leaving the base length. When vehicle passes time over the tube laid at first reference point air impulse is sent, which activates the electromagnetically.
		+ Controlled stopwatch in the hands of observer.
		+ Alternatively, readings can be observed by automatic data recorders.
		+ Disadvantage pressure contact tubes can be seen by driver and this may affect their behavior.
	3. Short distance method:
		+ Measuring speeds very short say 2m.
		+ Instrument are electronic and are used in conjunction with pneumatic tubes or electric detectors laid across the pavement.
		+ Recording can be manual being noted by the observers or can be automatic with or electronic system.
1. Radar speed meter:
* It works on doppler principle (change frequency of wave)
* Speed of moving body and change in frequency between radio wave transmitted for the moving body and received back.
* This instrument directly measures the speed and accuracy of atleast +1.5 to 3 KPH
* Instrument is portable and battery operated.
* Within 20o instrument is set up near the edge of carriage way at height about 1m speed and directions both can be measured.
* Method is used for traffic engineering studies as well as enforcement by traffic police.
1. Photographic method:
* It is used in crowded streets.
* In this pic are taken as fixed in travels of time.
* On special camera (say one second per frame).
* By projecting the film on the screen.
* The passage of any vehicle can be traced with reference to time.
* Images by video camera can also use.

**Delay studies:**

* Best are done by moving observer method; delays occurring due to stopping can be conveniently recorded by separate stopwatch.
* Special watches which can be found convenient for the purpose of which can accumulate delay time as operated by observer.

Two types of delays:

* **Stopped or fixed delay**: at intersection, railway crossing, stop signs.
* **Congestion delay or operational delay**: inadequate carriage way width, mixed traffic conditions, parked cars and heavy pedestrians.

Methods for measure running speed and journey speed:

* 1. Moving observer method:

Uses:

* Un biased estimate and neglisable error.
* Economical in man power.
* Speed and flow calculation as well as.
* Spot speed so that time mean speed.
* Additional information stops at intersection, delays, parked vehicles.
	1. Registration number method:
* Two observers in one direction with stop watch.
* 1 at entrance and 2 observer at terminal. Distance between 2 observer stations 0.5m- 1m.
	1. Elevated observer method:
* Observer stationed on top of the elevated building select vehicles at random and follow their course along the road, nothing the time of entering the test second, duration and nature of delay suffered and the time of leaving.

**Needs of volume count:**

* Volume of traffic using road in a given interval of time. Volume = vehicle/ hr or vehicle/day
* Traffic is composed of no. of types of vehicle. So we converting the flow into equivalent passenger car unit PCUs using certain equivalent factors. Now the flow expressed as PCU per hr or PCU per day.
* By knowing flow clearance. We can determine whether the particular section of road handling traffic much or below it capacity.
* If traffic is heavy road suffer because of congestion. Therefore, volume counts are necessary to improve traffic facilities.
* Structural design of road pavement we need to know no. pf commercial vehicle flow. It will good guide to pavement design.
* Maintenance of road also decided by no. of commercial vehicle per day.
* More people are involved in travelling useful for transport.

**Types of counts:**

1. Average annual flow, vehicle/year
2. Annual average flow, vehicle/day
3. Hourly flow, vehicle/day

# Volume

Needs for volume, classification and counts

* Volume of traffic (or) flow is expressed as vehicles/hr (or) vehicle/day.
* Traffic is composed of no of vehicles it is normal practice to convert the flow into equivalent passenger car unit (PCUs), by using certain equivalency factors.

3rTherefore, Flow is expressed as PCUs/hr (or) PCU/day.

* Knowing the flow char. We can determine whether particular sec of mad is handling traffic much above (or) below its capacity.
* If the traffic is heavy, road suffers from congestion with consequent loss in journey speeds &
* Lower speeds cause economic loss to the community due to time lost by the occupation of the vehicles & higher operational cost of vehicles.

Therefore, Volumes counts are indicators of the needs to improve the transport facilities.

* If traffic flow data are available over the past no of years, the rate at which traffic flow can be increased in the past can be easily determined. Extrapolating the past trend into the future, future rate of growth of traffic is made possible.
* No of commercial are using the road will its self will be a good guide in pavement design.
* Maintain needs of a highways is often based using road. Moreover no of commercial vehicles/day.
* Traffic regulatory & control systems are designed on the basis of accurate flow data.
* Evaluating the financial validity of private financed toll roads, the important consideration is volume of both present future volume data are collected very carefully for such projects
* The ultimate aim of travel is to transport men & goods.so we have to take no of occupants (or) people traveling in vehicle. If vehicle count puts available & the advantage occupancy of each type of vehicle is know the total no of persons easily calculated.

**Types of Counts:**

1. Level of measurements of flow
	1. Average Annual flow, expressed in vehicle/year.
	2. Annual Average Daily Traffic (AADT), vehicle/day.
	3. Hourly flow, vehicle/hr.

AADT = 1/365 of total annual flow

If the flow is not measured for all 365 days. only for few days the average flow is known as Average Daily Traffic.

1. Short term and long term counts:

Duration of the counts depends upon the purpose for which the data are needed and financial and man-power resources at the command of the traffic engineer.

**TYPES OF COUNTS:**

 The following are types of flows along with its purpose and use.

Methods Available For traffic count:

* + - 1. Manual
			2. Combination of manual and mechanical
			3. Automatic devices
			4. Moving Observer
			5. Photographic method

Manual Method:

No. of observers and No. of lanes in the highway.

|  |  |
| --- | --- |
|  |  |
| **Road features and Counting Required** | No. of vehicle/hr by 1 trained observer |
| * + - 1. 2-lane 2-way road, separate observer for each direction and classified.
 | 500 vehicle/hr one direction  |
| * + - 1. 2- lane 2-way road, 1 observer for both direction. Counted and Classified
 | 200 vehicle/hr both direction  |
| * + - 1. 2-lane 2-way-road 1-observer for both direction. Simply counting.
 | 800 vehicle/hr both direction |

* Observer should be literate and can be trained suitable for purpose with preferably middle or matriculation level qualification.
* For all day counts, work in 3 shifts of 8 hours each.

Equipment Method:

1. A watch
2. Pencils, Eraser and Sharpener
3. Supply of blank field data sheets
4. Clip board.

If 5 types of vehicles are to be counted the multi bank hand fall should have 5 counters, with a label stuck on each pressing knob indicates vehicle type. Pressing knob operates the counter and records the vehicle. This is additional equipment which is very handily.

Field data sheets and summery sheets:

* ` Multibank hand tally is not available, data is recorded conveniently by the fire-dash system.
* Field data sheet by IRC. This form is intended for last 4hrs.
* Data can be summarized for each hour of the day in the form prescribed by IRC.

For Example:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |
| Types of vehiclesHour count | Cars, jeeps, vans, 3wheels(2)  | Buses(3) | Trucks(4) | Motor- cycles(5) | Animal drawn Vehicle (6) | Cycles(7) | Other specify(8) | Total flow(9) | Remark |

1. Manual counts at intersections:

Field data sheets can be modified to suit the particular requirement of any intersection. Observer needs to be posted on each arm of intersection at four arm intersection. Count at each arm of the traffic entering the intersection can be broken down into three categories left turning, right and straight ahead. Above field data sheets can be modified to suit.

1. Combination of manual and mechanical counts:

Example for this is multi pen recorder. A chart moves continuously at the speed of clock. Different pens record the occurrence of different event on the chart. The actuations of each event recorder pen is by pressing the electric switch associated with each pen recorder.

Advantages:

(i) Permanent record is kept for each class of vehicle, classifications and count performed simultaneously.

(ii) Additional information such as time -headways between successive vehicles and arrival per unit time is available.

1. Automatic Devices:
* This device contains detecting the passage or presence of a vehicle called sensor or detectors and another for recording the count.
* The sensor usually transmitted some of Electric impulse which activates the accumulating register or recording chart.

SENSORS

1. Pneumatic tube

Flexible tube with one end sealed is clamped to the road surface right angles to the pavement. Other end of tube is connected to a diaphragm actuated switch. When axel of vehicle cross the tube, a volume of air gets displaced thus creating a pressure which instant closes the electrical contact through the switch. Two such contacts result in one count being registered thus represented two axles in a vehicle.

* + Inaccuracies are caused when vehicles with more than two axles.
	+ Because of simplicity and their cheapness pneumatic tubes are very popular.
	+ Difficulty may be caused in in fixing them to gravel surfaces and they are easily pilfered by vandals.
	+ Easily damaged by tractors\*tire chains\*snow ploughs and similar equipment.
1. Electric contact
* A pair of steel strips are contained in a rubber pad which is buried beneath the surface.
* On being pressed by vehicles weight steel strips come into contact with each other and causes electric current to flow.
1. Coaxial cable:
* Coaxial cable is clamped across the road surface, with capability of generating signals with the passage of axles. These signals actuate a transistorized counter.
* Advantage better reliability and less susceptibility to damage.
1. Photo electric:
* One end of road is source light which emits a beam across a road.at other end photocell passage of vehicles in the path of the light beam and causes a detection by a photo cell.

Disadvantage

Abstractions may can be caused by pedestrians and more than one vehicle in different traffic lane will be registered only vehicles.

1. Radars:
* Doppler effect is a well-known. when a moving object approach or recedes from a source of signal, the frequency of signals received by the back from the moving object will be different two frequencies causes detection of a moving object. Initial cost is high but its accuracy, reliability and not damaged by the traffic.
1. Infrared and ultrasonic:
* Infrared sensors can detect heat radiated from a vehicle or can react to a reflection from the vehicle of infrared radiation emitted by sensor. Ultrasonic is also used for vehicles detection. Both the types have same advent and equally expensive as a radar.
1. Magnetic:
* Disturbance caused in a magnetic field by a passing vehicle as a basic of sensing. The magnetic field itself provided by a wire coil buried beneath the road surface.

Recording mechanism

1. Counting resistors: This is simply accumulating counter indicating directly the number of vehicles on a meter. Readings must be taken before and after the period.
2. Printed output: This device prints accumulated total at regular intervals of time on a roll of a paper, resting the counting register to zero at the end of the each time interval. Time of the day and number of the vehicles are printed side by side\*time interval 1hour, 30min,15min.
3. electronic systems: Hard disks, floppies, discs

Maintenance of automatic devices

* For accuracy and reliability proper maintenance is necessity.
* Accuracy of clockwork mechanism needs to be check periodically.
* Recording devices used to work 6volts batteries, which need to be charged at regular intervals.
* All automatic devices mentioned above need attention.

# Parking

**Problems**

* Not only vehicles need street space to move, but also need space to park where the occupants can be loaded and unloaded.
* Every vehicle owner would wish to park vehicle as closely as possible to his destination so as to minimize his walking.

**Ill effects of parking**

1. Congestion:

Capacity of street is reduced, journey speed decreases and the journey time and delay increases.

2. Accidents:

Careless opening of doors of parked vehicles, moving out of a parked position and bringing a car to the parking location from the main stream of traffic are some common causes of accidents.

3. Obstruction to firefighting operations:

Parked cars obstruct the movement of fire fighting vehicles. They block access to hydrant s and access to buildings.

4. Environment:

Stopping and starting of vehicles result in nose and fumes. Cars are parked into every little available space debase the visual aesthetics and " buildings seem to rise from a plinth of cars".

5. Zoning and parking space requirement standards:

* On street parking and its regulation will be an important aspect of the overall parking policy of a town.
* New or remolded buildings will be requirements to have within enclosed land around house
* Advantage of zoning and land use controls for steering safe and efficient traffic have been well recognized.

|  |  |  |
| --- | --- | --- |
|  |  |  |
| Sl no. | Land use | Parking space |
| 1 | Residential i)Detached and semi-detached row housesPlots areas:Up to 100sq.m101 - 200sq.m201 - 300sq.m301 - 500sq.m501 - 1000sq.m>1000sq.mii)Flatsiii)Special or costly developed areaiv)multi storied  | No space requiredOnly community parking space is RequiredMin 1/3 rd for open area.Min ¼ th for open area.Min 1’6 th for open area.Open space for every 2 flats 50-99sq.m or more floor area.Open space for every 50-100sq.m. one and half space for every flat of 100 to 150sq.m of floor area. 2 spaces >150sq.m.One space for every four dwellings except cities where demand may be more. |
| 2 | offices | 1 space for 70sq.m of floor area |
| 3 | Industrial premises | 1 space for up to 200sq.m of initial floor area |
| 4 | Shops and markets | 1 space for every 20sq.m of floor area. |
| 5 | Restaurants | 1 space for every 10 seats. |
| 6  | Theaters and cinemas | 1 space for every 20 seats |
| 7 | Hotels and motels* 1. 5 or 4 star
	2. 3 star
	3. 2 star
	4. Motels
 | 1 space for every 4 guestrooms.1 space for every 8 guestrooms.1 space for every 10 guestrooms.1 space for every guest room. |
| 8 | Hospitals | 1 space for every 10 beds. |

**Design standards for on-street parking facilities:**

**Common methods of on street parking:**

1. Parallel parking
2. 30o angle parking
3. 45o angle parking
4. 60o angle parking
5. Right angle or 90o angle parking

**Regulatory measures for on street parking:**

* On street parking is extravagant or excessive use of precious street space.
* A judicious application of approximate traffic management measure will help extent some of ill effects of on street parking.

2 types of regulatory measures use

1. Use of parking space is authorized for certain periods free or for payment.
2. Where parking prohibited but which for picking up or setting down goods and passengers.

Prohibited parking:

1. Near intersections:
* 50 m away from intersection
* Visibility adversely affected and safety is reduced; capacity intersection reduced.
1. Narrow streets:
	* two way streets <5.75m wide & one way street <4cm prohibited.
2. Pedestrian crossing:
* Pedestrian crossing are worst suffering. parked cars obstruct visibility at pedestrian crossing. 8m from pedestrian crossing, parking prohibited.
1. structures:
	* Bridges, tunnels & under passage gently have roadways width so durable to prohibit parking on them.
2. Entrance drive ways:
	* Houses & buildings in front of these structures prohibited. Normally period 8am (or) 9am to 6pm (or) 9pm. Prohibited & relaxation in Sunday's.

Free parking limited period:

* + Free parking is allowed designated stalls on limited period. Adoption of these scheme are availability sufficient parking spaces to meet the demand. Parker's should leave their vehicle for a time which is less than a posted limit.

Parking meters:

These are two types:

* + Manual meter: Manual meter is operated by inserting appropriate coin and working handle (or) lever. This activate clockwork mechanism of meter.
	+ Automatic meter: Automatic meter wound up periodically (once in a week) attendant upon insertion of coin needle shows time and it will start moving across time scale on the face of the meter until the period of time brought has expired.

Generally, Meter can be two types:

* + Canceling (or) non-cumulative:
		- Unexpired time remaining on meter it canceled out by insertion of next coin.
		- Next motorist gets more time than he actually pays.
	+ Cumulative:
		- Unexpired time is added to time period of next motorist.
* Metering plan is reverent to favor shot time parameter and to parking turnover.
* Time limit judiciously selected.1hr is satisfactory limit for central area of the city.
* Near post office, bankers and public utility off 15-30 minutes should be sufficient for motorist to finish their work.

Advantages of parking meter:

1. 4 (or) 5 cars can use single parking in a day out provides short term Parker.
2. Time check is very accurate and easy to violators.
3. Dangerous parking is avoided because park bays are process precisely.
4. Parking inform of important buildings and near ingest avoided.

Disadvantages:

1. Strick enforcement is necessary for its success.
2. Bay are uniformly marked with reference to largest car operating in the country.
3. If we want to park long term.
4. Meter scheme is a solution to only a part of park.

Parking discs:

* Disc is displaced by motorist on wind-screen, showing time of arrival and time by which the vehicle has to leave the parking space.
* No fee is charged and promotes short-term parking.
* Enforcement more attentive than meter systems. Since abuses may be more common.
* Setting and displacing the disc correctly is motorist responsibility.

**Off- street Parking:** (consideration locating off-street parking)

1. Surface car parking
2. Multi-storied car
3. Roof parks
4. Mechanical car parks
5. Underground car parks

Primary consideration should be nearness to the place of usage by the 30 prospective customers. Proposed facility should be close to major parking generators.

 Surface car parks:

* Located and developed on a piece of vacant land or surrounding an office complex or supermarket are very popular with the motorists.
* Great care is needed in their design and operation.
* A stall size 2.5m × 2.5m is probably adequate for Indian condition predominated by small size cars.
* Type of layouts depending on area.
* If it is fee-charging system, there should be arrangement for collecting the money.
* That can be either manually by stationing an attendant at entrance who cells parking tickets or by installing an automatic ticket vending machine which can be designed to raise a barrier rail upon insertion of coin.

 Multi-storied car parks(MSC):

* Surface parks consume too much of the precious land in heart of city.
* One of the alternatives when land is costly is to provide multi storied car parks such facilities became common and popular in many cities.
* MSC are designed for a capacity of about 400 to 500 cars.
* Large capacity tends to increase the time for un parking a car.

 Design standards for designing of multi-storied park:

1. Gradient of the ramp: 1 in 10 generally and 1 in 8 for every short ramp.
2. Clear height b/w floors 2.1m
3. Parking stall dimensions 2.5m × 5 m
4. Inside radius of curve 7m.
5. Width of traffic lane on ramps and entrances 3.5m.
6. Gradient of sloping floors: Not steeper than 1 in 20
7. Loading standards 400kg/m2.
* Arrangement of the floors and the access ramps needs careful thought and large no. of alternatives are available.
* Ramps are preferably made one day.
* If two way they should be divided.
* Continuously sloping to gain access from one level to another.
* Horizontal floor with separate helical entrance and exit ramps have been found efficient.
* Car parking floors, the ramps, Entrances and exits should be well lighted.
* Operation of multi storey car parks can be with customer or attendant parking or a combination of the two.

Roof parks:

* Very popular methods of solving parking problems adopted in many cities is to park vehicles on roof tops.
* Access ramp mechanical lifts provide necessary access to the roofs.
* To economize, many roofs may be linked together sensed by a single access ramp.
* In addition to ramps extra cost is involved in designing the roof tops and structural elements for parking.

Mechanical car parks:

* Provided for lifting of the cars from floor to floor by means of lift.
* Transfer of cars to and from the parking stall by means of wheeling or mechanically operated transfer dollies or cradles.
* Since ramp and aisles are estimated.
* If is more economical compared to ramped system multi stories system.

Disadvantages:

Higher maintenance cost and possibility of breakdown due to mechanical or power failure.

Underground car parks:

* Great advantages of underground car parks are least intrusion they cause to the aesthetics of a place.
* These can be built in the basement of any multi storied building or below open spaces.
* Work involves large quantities of excavation, construction of retaining walls ventilation and lighting such a car parking tends very costly.
* Underground car parking can be single storied or multi storied.

**Peripheral parking schemes:**

* Center of town is the worst hit by the parking problem.
* It is natural to think in terms of providing parking facilities at periphery of the town.
* Induce motorists to park there and travel to the busy town center by some other mode.
1. Park and walk:
	* Park at outskirts of town and walk down to town.
	* Inducement is in the form of lower parking charges at the periphery than at town center or no parking charges.
2. Park and ride:
* This scheme provides parking facilities and public transport side to the destinations in the town center.
* Attractive scheme has been tried with success in many towns.
* Since motorist voluntary park his car.

Total travel time including parking time waiting time at the bus stop and travel time by bus should not be excessively high to make him look at it with disfavor.

* Cost peripheral parking charge + charge for to and fro journey by bus < cost of travel by his car + charges for parking in(cities) town center.
1. Kiss and ride:
* Dropping her husband in the car in the morning near a bus stop from where the husband goes to work in a bus.
* The reverse operation takes place in the evening.
* Adequate space for parking of cars near the bus stops where the husbands can be dropped off or their arrivals awaited is an essential prerequisite for the success of the scheme.

Loading and unloading facilities:

1. Bus-Bays:
	* Bus bays recessed into the curb, facilitate loading and unloading of passengers without vehicle blocking the stream of traffic on carriage way.

 Guidelines for location of bus bays:

1. Bus stop should not be located too close to intersect minimum distance 75m from intersection for urban 300m for rural desirable.
2. Bus stop located as to set down the passengers at safe places such as curbs.
3. Intending to turn right at an intersection, stop should be sufficiently away.
4. Length of recess should be 12-15m for single bus for every additional bus 12-15m left. Taper on either side should be about 8:1, the maximum valve being 6:1.
5. Commercial traffic:
	* Loading and unloading of goods by trucks on the roadside demands upon the space reserved for pedestrians as well as for moving vehicle.
	* Problem can be controlled by permitting loading and unloading only b/w 6pm to 8 pm or by permitting Loading and unloading at specified location.

ie., providing (long-term) adequately designed truck terminals outside the cities.

1. Truck terminals:
	* Parking of trucks in the streets and upon spaces of the towns and cities has many adverse effects.
	* Pre-most is the degradation of environment and hazard to traffic.
	* Security of the goods contained in the parked vehicle can also serious problem.
	* Truck drivers who have often to drive for long hours and consequently need rest, toilet facilities and food deserve careful consideration.
	* Right approach is to provide well designed truck terminal at outskirts of cities.
	* Length of truck berths depends on type of trucks to handle.
	* Truck trailer combination obviously need longer than single unit trucks.
	* Alternatively, pre-quad questionnaire may be distributed to person residing at stations outside the survey area and are collected at station inside the survey area.

**Presentation of Results:**

* Origin and destination survey yields a vast amount of data. To understand them it is necessary to present them in convenient tabular or pictorial form.
* The most convenient form is origin and destination matrix. Origin zones and destination zones are represented.
* Most popular pictorial representation is by means of a desire line chart i.e., trips b/w any pair of zones are by straight line connecting the centroid of the two zones and having band width drawn to a suitable scale to represent the actual volume of trips.

# Parking surveys

**Need for parking surveys:**

* It is one of the serious problem that deals with urban planner and traffic engineering available parking space, Extent of its usage and parking demand are essential.
* If it is proposed to implement a system of parking charges it will also be necessary to know how much to charge and what will be the effect of pricing policy on parking.
* Parking survey needs all this kind of information.

COMMON TERMS:

Parking Accumulation: Total no. of vehicle parked on an area at a specified moment.

Parking volume: No. of vehicles parking in a particular area over a given period of time measured in vehicle/day.

Parking load: The area under parking accumulation curve during a specified period.

Parking index: Percentage of parking bays actually occupied by parked vehicle as compared to the theoretical number available.

 P.I = No. of bays occupied × 100 ÷ Theoretical no. of bays available

Parking turn-over: Rate of usage the available parking space.

 10 parking space used by 100 vehicles in a period of 12hrs.

 Therefore, parking turn over = (100÷10) vehicle / space in a period of 12 hrs.

**Types of Parking surveys:**

1. Parking space inventory
2. Parking usage survey by patrol
3. Questionnaire type parking usage survey
4. Cordon count

Parking space inventory:

* Central business district is usually the area where parking survey in needed and area surrounding central business districts where the parking spills over should also be included in survey.
* The survey area is them subdivided into street by street basis and sub-divisions marked on a map. Then sketch marks are prepared in advance.

Items should be recorded as follows:

1. Total length of curb, and length governed by no waiting and limited waiting restriction.
2. No. of parking space provided in street.
3. Street width
4. Location of bus stop, bus bays, pedestrian crossings, fire hydrants, loading zones, taxi stands and other features will affect because using street parking.
5. No. of types of traffic signs for regulation of parking.
6. Vacant or unused land suitable for temporary or permanent parking space.

For single unit truck space of 3.75m × 7.5m per vehicle is adequate

For truck trailer combination 15m may be needed.

Width of loading platform should be 3.5 to 4.5m.

**Long distance bus terminals:**

* In towns, it is desirable to design bus terminals to handle exclusively long distance bus traffic.
* Such terminals should preferably be outside the congested portion of the town.
* If a town has ring road the ideal location in many cases is the ring road itself.
* Terminal should be planned such that one-way circulation of buses is achieved.
* Pedestrian movement will be heavy in a terminal and should as far as possible, not conflict with vehicular movements.
* Platform where pedestrian wait should raise.
* Parking facilities for car, scooter, cycle, taxis etc. should be provided.
* Terminal should be planed for anticipated future traffic in the design year.
* Bus width generally 2.5m and it is desirable have 3.3- 3.75m wide lanes. Length of bus about commercial vertical clearance 3.75m.
* Passenger platform should have minimum width of 2.5m.

**Parking Usage Survey by Patrol:**

Purpose:

* Survey is to obtained data on the extent of usage of parking spaces.
* Survey counts parked vehicle at regular intervals through a period, covering both morning and evening peak period and parking accumulation and turn-over.
* Survey can be on-street or off-street parking.
* Methods for both the surveys similar. Some minor difference will be there.
* Method consist of making periodic observations of parked vehicle on each patrol.
* Off-street observations the entire parking space can be patrolled on entrance and exit may be observed continuously.

Mapping street system:

Steps:

1. Preparing map of street system that will be covered by patrol it has to show its sub-division into sections.
2. Street junctions make convenient points for determining the sections
3. Recording can be for both side of roads or smooth for each other.
4. Map and forms should clearly show the direction of travel by patrol ma and the side or sides where observations are to be side or sides.

The length of streets to be covered by a patrol is

* + 1. Speed of walking while noting the registration number.
		2. Frequency of patrol.

A speed 900m in half an hour is useful guide.

Frequency of patrol:

* More frequent patrols result in more accurate data filed work and subsequent become more tedious.
* A frequency of ½ hr considered to be satisfactory for on-street parking. For off-street 1 hr patrol used.
* A frequency ½ hr may miss short term street parkers. This makes it necessary to have more frequently patrols in selected areas where short-term parking may be significant.

 Ex: near banks, post office.

 Methods of observation:

 Usually patrols are by foot, if vehicles are not parked too close to one another a moving car also used. A tape recorder may be used to record the registration number of vehicle.

Timing of survey:

 Done in week days. Period of survey 10-12 hrs so to cover the arrival and departure of customers and shoppers.

# Traffic signs

**Importance:**

* Timely warning of hazardous.
* Regulating traffic by imparting messages to the drivers about need to shop give way and limit their speeds.
* They give information as to highway routes, directions and points of interest.

**General Principles of traffic signing:**

1. Traffic signing should be installed only by authority of law. Unofficial and Non-Essential signs should not permit.
2. For imparting a sense of respect towards signs, proper enforcement measures should be taken.
3. Excessive use of signs shouldn’t be more. Conservative use of warning and regularly signs is recommended.
4. Signs should be put up only after traffic engineering studies.
5. High visibility, both during night and day.
6. Lettering or symbols of adequate size for being read from far way.
7. Simplicity and uniformity in design, position and application.
8. Location at conspicuous position to be able to be seen by drivers.
9. It is desirable that there should be two sizes for types of sign.
	* 1. Standard size (b) a reduced size.

Where conditions do not permit in the safety of road users doesn’t require the erection of the standard size.

**Types of Traffic signs (3 types):**

1. Danger signs or warnings signs or Cautionary signs:
	* Necessary to warn traffic of existing or potentially hazardous conditions on or adjacent to a highway or steel.
	* Warning signs are of great help in ensuring safety of traffic.
	* Should be keep minimum because their unnecessary use tends disrespect for all signs.
	* IRC standard 900mm for a standard size, 600mm for a reduced size.
	* Signal have red border and symbols are black in color with white background.
2. Regulatory signs:
	* Signs giving definite instruction sub divided into
3. Prohibitory signs:
* To inform the highway users of traffic laws or regulations.
* This signs gives definite negative instructions prohibiting the motorist from making particular manoeuvres.

Types:

* + 1. Movement Prohibition: Examples-certain turns, prohibited of entry, prohibited overtaking, One-way Traffic.
		2. Waiting restrictions signs, such as prohibited waiting.
		3. Restrictions on dimension, weight or speed of vehicle.
* According IRC these signs are circular shape of 0.6m dia standard 0.4m for reduced size.
* Signs have red border, white color background for speed control, blue for waiting and parking restrictions and direction control also. Symbols are black in color per prohibited and white in color for direction control signs.
1. Mandatory signs:
* These are intended to convey definite positive instructions when it is desired that motorists take some positive action.
* 2 important mandatory signs are (i) stop (ii) Yield or Give way

STOP:

* These signs require all vehicles to come to half before the stop line.
* Because it causes substantial inconvenience to motorists.
* It is generally used at intersections should be used follows
	1. Intersection of less important roads with a main road.
	2. Street entering a through highway or street.
	3. Un signalized intersect in a signalized.
	4. Where combination of high speed, restricted view and serious accident record indicates a need for control by stop sign.

Shouldn’t be used:

1. On through roadways or expressways.
2. For speed control
3. At signalized intersection.
* IRC octagon with white border and red background and sides of octagon being 900mm for stand and 600mm for smaller size.
* Combination with a definition plate carrying message stop.

Yield or Give way:

* Used to assign right of way to traffic on certain approaches to an intersect.
* Vehicle controlled by yield sign need to stop only when necessary to avoid interference with other traffic that is given the right of way.

They are used in under following conditions:

1. On a minor road at the entrance to an intersection where it is necessary to assign right of way to major road where stop is not necessary at all times.
2. Entrance ramp to an express-way when acceleration lane is not provided.
3. If there is separate or channelized left-turn lane without adequate acceleration lane.
4. Within intersection with a divided highway where entrance stop sign is present at entrance to 1st road way and where median width b/w two road ways exceeds 9m.
5. Where special problem exists at any intersections.

Shouldn’t be used:

1. Control the major flow of traffic at intersection.
2. On the through roadways or expressways.
3. On the approaches of more than 1 of the intersection streets or highways or at any intersection where there are stop signs on one or more of the approaches, except under special circumstances, to provide minor movement control within complex intersection.
* IRC downward pointing equilateral triangle red border and white background. 900mm standard triangle 600mm long smaller size.
* Shall be used in combination with a definition plate carrying massage “GIVE WAY”.
1. Information signs: (3 types)
	* Intended to guide motorist along street and highways to inform him of intersecting routes, to direct him to cities, towns. Villages or other important destination to identify nearby rivers and streams, parks, forests generally to give him such information as will help him.
	* Signs not lose their effectiveness by over-use.
	* Important dealing with provision of informatory signs is the size of lettering.
	* Letters should be of such size as can be easily read when the vehicle are moving at speed.
		1. Indication signs:
			+ Provide information of facilities such as hospitals, filling station, telephone, eating place, first aid etc.
			+ Generally required shape 600mm × 450mm with black symbol, blue background and white rectangle.
			+ Information regarding parking facilities are frequently needed.
		2. Direction signs, Advanced direction signs and place identification:
			+ Sign indicate name of the place and rectangular in shape, terminating in the form of an arrow head.
			+ Advanced direction signs are necessary at intersection of roads. They are Rectangle in shape.
			+ Reassurance sign reassures the traveler about the places ahead and the direction.

Overhead signs:

Used to provide following consider exist

1. Traffic volume at or near capacity
2. Complex interchange
3. 3 or more lanes in each direction
4. Restrict sight distance
5. Closely spaced interchanges
6. Multi-lane exists
7. Large percent of trucks
8. Street lighting background
9. High speed traffic
10. Right exist ramps

Existence of any or more of the conditions listed doesn’t automatically justify the use of overhead signs.

Height of the panel ranges from 125cm to 305cm, depending on no. of line sand messages. Letter size range 25-30cm. Vertical clearance needed in India 5.5m.

**Types of Supporting Systems:**

1. Cantilever with one post
2. Butterfly with one post
3. Two post unit

Route Marker signs:

RMS for national highways has been standardized in India by IRC. It consists of shield painted on a rectangle plate 450mm × 600mm. Sign has yellow background and lettering and border are in black.

Location, height and maintenance of traffic signs:

* Located at left side of road. Repeated on other side of carriage on multiple line carriage ways.
* On wide expressways, overhead signs may also necessary.
* On hill road, they are normally fixed valley side of road.
* IRC not less than 60cmaway from edge of kerb in case of kerbed roads and distance 2-3m from carriage way edge in unkerbed roads.
* Stop sign located at point where vehicle has to stop or near there to say 1.5 to 3m if there is pedestrian crossing stop shall be 1.2m in advance of pedestrian cross stop line.
* Give way sign located at near to point where the vehicle is to stop say distance 1.5 to 3m it should be erected 1.2m in advance of marking.
* Warning sign: to be located at the following distance in advance hazard warned against,

|  |  |  |
| --- | --- | --- |
|  |  |  |
| Non-Urban locations | Plain and rolling terrain | Hilly or mountainous terrain |
| National Highways and State Highways | 120m | 60m |
| Major District Roads | 90m | 50m |
| Other District Roads | 60m | 40m |
| Village Roads | 40m | 30m |

For urban location: 50m

* Sign post should be maintaining proper position.
* Damaged signs should be removed and replaced immediately.
* Periodic painting of signs should be routine part of maintenance.

 Variable Message Signs or Dynamic Message Signs:

* Which can be changed whenever need by means of remote control at a centralized location.
* Information such as severe weather conditions, incident notification (accident, road closure) congestion, travel time b/w distance.
* UMS display board uses high intensity LED’s generally yellow color size of letter 380-400mm.

# Traffic signals

* + 1. Advantages:
* Orderly movement of Traffic flow.
* Because of proper layouts and control measures, they can increase the traffic-handling capacity of intersection.
* Reduce frequency of certain types of accident.
* Under favorable condition, they can be coordinated to provide for continuous or nearly continuous movement of traffic at definite speed along given route.
* Used to interrupt heavy traffic at intervals to permit other vehicular or pedestrian to cross.
* Traffic signals dispense with police control and can thus be economical.

Disadvantages:

* Excessive delays to vehicle may be caused, particularly during indication.
* Unwarranted signal installation tends to encourage the disobedience of signals.
* Driver may use less adequate and less safe routes to avoid delays at signals.
* Accident frequency, especially of rear end type may increase.
* When installation breakdown, total and widespread confusion and difficulties can result.
	+ 1. Signal Indication:
			- Indian practice:
				* Amber period 2 seconds as transition interval b/w termination of related green movement and exhibition of indication or b/w termination of red indication and commence of green movement.

Pedestrian Signal indication: Red standing man represents don’t cross and green walking man represents indication cross.

Flashing amber: Signal is a hazard identification beacon is normally used to warn of obstruction and intersections to supplement regulatory signs and to warn of mid block cross walks.

* + 1. Signal Face:
			- Minimum number of senses in a signal face is 3- red, amber, green. Maximum no. of American practice is 5.
			- Lenses in a signal face can be arranged in a vertical or horizontal straight line.
			- Relative position top to bottom or left to right are red, amber, green.
			- Lenses normally of 2 sizes 200mm and 300mm dia.
			- Large size used where 85% approach speeds exceed 65 KPH; for special problem. Location, for all arrow indication, for intersection where signalization unexpected and for intersection where drivers may view both traffic control and lane direction signs simultaneously.
			- IRC recommended size 200mm for light signals intended for drive, 300mm for green arrow signals and 300mm for signals intended for pedestrians.
			- Arrow pointed vertically upward to indicate a straight through movement and in horizontal direction to indicate a turn at approximately.
		2. Illumination of Signals:
			- Illumination of signals as to be visible for a distance of atleast 0.4km under normal atmospheric conditions.
		3. Number and location of signals faces:
			- American practice: Minimum of 2 signals faces to be provided and be visible from a point atleast. Normally one primary signal is installed at 0.9m from the stop line and secondary signal is commonly installed diagonally opposite the 1st primary signal on the back, on the back of the primary signal intended for opposite traffic.
			- Indian practice: When erected the center of the amber signals shall not be less than 2.4m nor more than 4m above carriageway level.

Amber period:

Indian practice: Amber interval is a transition interval b/w termination of related green movement and exhibition of a red indication or wise versa b/w termination of red and commencement of related green movement.

 1st case it is called “Clearance Amber” and 2nd case “Initial Amber”. Amber period is 2 seconds.

* Cycle length is time required for one complete sequence of signal indications phase is defined as sequence of condition applied to one or more streams of traffic.

Fixed Time Signals and Vehicle actuated Signals:

1. Which the green periods, hence the cycle length is predetermined and of fixed duration.
2. Vehicle actuated signals, are which the green period varies and are related to the actual demands made by traffic. Popular in U.K.
3. Intermediate type semi-vehicle actuated on all the available i.e., right of way normally rests with the main road and detections are located only on side roads.

|  |  |  |
| --- | --- | --- |
|  |  |  |
| Type | Advantages | Disadvantages |
| Fixed time | i) Simple in constructionii)Relatively in expensiveiii)Most successfully used in linked system required fixed cycle length for a given pattern. | i)Inflexible cause avoidable delayii)Required careful setting |
| Vehicle-actuated | i)Flexible and able to adjust to change in traffic condition automaticallyii)Delay held minimum and maximum traffic capacity achieved | i)costly equipmentii)Can’t provide signal coordination |
| Semi-vehicle actuated | Useful for junction of a side street having low traffic volume with main street having flow | Cause high accident rates at times of light traffic. |

**Determination of Optimum cycle length and signal setting for intersection with time signals:**

* Important step in fixed time signals system is to determine the cycle time.
* Main consideration is selecting the cycle time should be outlined that the least delay is caused to the traffic passing through the intersection.
* In selecting a cycle time other guiding factor is proportion of the time lost (in the inter green period and starting delay) to the cycle time.
* If the cycle time is small, the proportion of the time lost to the cycle time will be high resulting in large, proportion of time lost to the cycle time will be small and signal operation will be more efficient.
* If the cycle time is too large, there is danger that a good portion of green time will be used by unsaturated flow of traffic which again leads inefficiency.
* For each traffic flows, there is an optimum cycle time which results minimum delay to the vehicle.
* From graph traffic flows, there is an optimum valve the delay is never more than 10-20% above that the given optimum cycle time.
* Result could be used in determining the comprise cycle time that would suit variation inflow during the delay.

Total delay for intersection w.r.t cycle time for the optimum cycle time,

Co = $\frac{1.5L+5}{1-Y}$ seconds

Co = optimum cycle time

L = total lost time per cycle

Y = y1+y2+y3+…….. +yn ;

y1, y2, y3, ……… are the maximum ratios of flow to saturation flow for phase.

* Fig 1 shows that as soon as green signal is given, rate of discharge begins to pick up and some time is lost before the flow reaches maximum value.
* Similarly, termination of green phase, flow tends to taper off further lost time

Lost time L = K + a – g

For phase K = green time for phase

 a = Amber time for phase

 g = Effective green time = b/s ; s=saturation flow

 therefore, b = No. of vehicle discharge on the average during a saturation flow

* Total lost time due to delays per cycle will be l, if there are n phases in cycle.

In addition to this lost time, time R during each cycle, when all signals display red simultaneously is also lost to the total traffic.

 Therefore, Total lost L = nl + R

* Value Y sum of y values for each phase will handle one or more intersection, each approach having its own traffic flow and saturation flow.

 y, value taken a s highest ratio of traffic flow to saturation flow.

* Effective green available in a cycle can be apportioned to the difference phases as

 g1:g2:g3:……:gn = y1:y2:…..:yn

 = effective green time allotted to phases = 1,2,3,4,….,n respectively

From practical consideration, tower limit of the cycle time may be taken as 25 second upper limit may be regarded as 2 minutes.

Saturation Flow:

 Determine y values, saturation flow should be measured rather than estimated value. For designing new signal installation. Following form devised by Road Research Laboratory.

 S = 525 w PCU/hr

S = Saturation flow

W= width of approach road in meter measured kerb to inside of pedestrian or center line, whichever is nearer or to the inside of central reserve refuse in case of dual carriage way.

* When approaches are in gradient, saturation flow needs some adjustment approx. This can be done by decreasing the saturation flow by 3% for each 1% uphill gradient and increase in saturation flow by 3% for each 1% of downhill gradient.

Effect of Right – turning traffic on the saturation flow accounted as follows:

1. No opposing flow, no exclusive right turning lanes

For this calculation using above eq S = 525w PCU/hr

1. No opposing flow, exclusive right turning lanes

Saturation flow of right turning stream through a right angle should be obtained separately.

 S = $\frac{1800}{1+\left(\frac{1.52}{r}\right)}$ PCU/hr for single file streams.

 S = $\frac{3000}{1+\left(\frac{1.52}{r}\right)}$ PCU/hr for Double file stream file stream

 R = radius of curvature of right turning stream

1. Opposing flow, no exclusive right turning lanes:

Effects are possible under these circumstances.

1. Opposing traffic, the right turning are delayed themselves and consequently delay.

Non- right turning vehicle in the same stream.

1. Their presence tends to inhibit the use of off-side lane by straight ahead vehicle.

These two effects can be allowed by assuming that on the average. Each right turning vehicle is equivalent to 1.75 straight ahead vehicle.

1. It pertains to the discharge of right turners through suitable gaps in the opposing (flow) stream.

∴ maximum no. of right turn vehicle nr = Sr × $\frac{gs-qc}{s-q}$

 Sr = right turning saturation flow

 g = green time

 c = cycles time

 q = flow in opposing arm

S = saturation flow for opposing arm

Average no of right turning lanes per cycle is > nr, then difference b/w two nw will have to wait at the intersection at the terminating of green time. For allowing all these nw vehicle to clear the intersection, inter green time can be made equal to 2 $\frac{1}{2}$ nw sec, assuming each vehicle takes 2 $\frac{1}{2}$ sec to clear.

1. Opposing flow, Excessive turning lanes:
* There is no delay to straight ahead traffic using the same approach as the right turners.
* But there will be effect on the cross phase and this should be calculated.as outlines
* If % of left turner is <10. Then it is degraded.
* If >10% then corrections are made.

Assuming Each left turner is equivalent to 1.25 straight ahead vehicles.

IRC laid these 4 warrants, one or more of which must be met with before signal can be installed.

**Warrants for signals:**

IRC warrants 1: Minimum vehicle volume

 Traffic volume on major streets and the higher volume minor street for each of any 8hr of an average day. Should be equal to values

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| No. of lanes | Vehicle/hour on major street(both approaches) | Vehicle/hour on minor street(one direction only) |
| Major | Minor |
| 1 | 1 | 650 | 200 |
| 2 or more | 1 | 800 | 200 |
| 2 or more | 2 or more | 800 | 250 |
| 1 | 2 or more | 650 | 250 |

Warrant 2: Interruption of continuous Traffic.

 Traffic volume on major street and higher volume minor street for each street of average day

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| No. of lanes on each approach  | Vehicle/hour on major street(both approaches) | Vehicle/hour on minor street(one direction only) |
| Major street | Minor street |
| 1 | 1 | 1000 | 100 |
| 2 or more | 1 | 1200 | 100 |
| 2 or more | 2 or more | 1200 | 150 |
| 1 | 2 or more | 1000 | 150 |

Warrant 3: Min pedestrian volume

 For each of any hour of any 8hr of average day following traffic must exists

1. On the major streets, 600 or more vehicles/hour enter the intersection (both approaches) or there is a raised median island 1.2 m or more in width, 1000 or more vehicle/hr both direction enter intersection.
2. During same 8hr, there are 150 or more pedestrians/hr on the highest volume cross=walk crossing major street.

Warrant 4: Accident experience

1. Adequate trail of less restrictive remedies with satisfactory observance and enforcement have failed to reduce the accident frequency.
2. 5 or more reported accidents, of types susceptible of correction by traffic signal have occurred within period of 12 months.
3. Signal installation will not seriously make a break in traffic flow.

**Coordination control of signals:**

Need:

* Desirable to reduce delays and avoid main traffic from having to stop at every junction.
* Signal indicates a stop aspect at a junction, a queue of vehicle is formed behind stop line. When signal changes to green, vehicle start moving in platform.
* If this platoon in made to meet a green aspect at the next junction no delay is caused to vehicle.
* This principle of linking adjacent signals so as to secure maximum benefits to flow of traffic is called coordinates of signals.

Objects of coordinates:

1. To pass maximum amount of traffic without enforced halts.
2. Have minimum overall delay t traffic streams both in main and side roads.
3. Prevent queue of vehicle at one intersection from extending and reaching next intersection.

Off set:

Difference b/w the start of green time at successive upstream and downstream signal.

* It is important consideration planning coordinates system.
* If start of green at downstream signal is offset at particular value such that platoon, which starts at upstream signal upon green indication there arrives at downstream signal just time for green signal platoon has Unhindered movement.

Time and Distance diagram:

* Planning as system of coordinates signal control, indication the system diagrammatically known as “Time and Distance” diagram.
* Time and signal settings are indicated along the horizontal axis suitable scale.
* Distance travelled along the major rote is plotted vertically to suitable scale.

**Types and Coordinates signal system: 4 systems**

1. Simultaneous system or synchronized system:
	* Signals along this street always display same indication to the same traffic stream at the same time.
	* Division of cycle time is the same at all intersection.
	* A master controller is employed to keep the series of signals in step.

Disadvantages:

1. It is not conductive to give continuous movement of all vehicles.
2. It encourages spending of drivers between stops.
3. Overall speed is often reduced.
4. Because the division of cycle time is same all the intersections, inefficiency is inevitable at same intersection.
5. Simultaneously stoppage continuous line of traffic at all intersections often results in difficulty for the side street vehicles in turning or crossing main side street.
6. Alternative System: (limited progressive system)
	* In this consecutive signal installation along a given road show contrary indications at same time.
	* This permits vehicle to travel one block in half the cycle time.
	* It is very efficient when blocks are equal lengths.

Disadvantages:

1. Green times for both main and side streets have o substantially equal resulting inefficiency at most of the intersection.
2. If blocks length is unequal, the system is not well suited.
3. Adjustments are difficult for changing traffic condition.
4. Simple progressive system:
	* In these various signals along a street display green aspects in accordance with a time schedule to permit as nearly as possible, continuous operation of platoons of vehicle along the street at a planned rate of motion.
	* Offset at each installation is determined so as to secure the best continuous movement of platoons in both directions.
	* These offsets are fixed and can’t be altered at different periods of the day.
	* Each signal installation had a cycle division different from the others but division remains fixed throughout the day.
5. Flexible progressive system:

This is improving over simple progressive system with follow provision.

1. It is possible to vary the cycle time and division at each signal depend on traffic.
2. Possible to vary the offset.
3. Possible the introduce flashing or shut down during off peak hours.

**Signal Approach Dimensions:**

* Approach dimension have an influence on the design and perform of intersection.
* Modify the approach dimensions. We can improve the efficiency of signalized intersection.
* Signal permit traffic movement from any approach for only a proportion of the time reason that is approach roads in immediate vicinity of the intersection should have wider roadway than the normal.
* These when planning or improvement in the geometric layout of existing intersection or planning for new facilities, it helps to keep in view the improvement in flow conditions for new achieved with wider approaches.
* Webster and Newby have produced the following rules for determine approach
	+ For 2 phase cross roads the approach widths should be proportion to the square roots of the flows.
	+ q1 and q2 are maximum flows on phase1 and 2 respectively, green times g1 and g2 length widened d1 & d2 , width w1 & w2 are related as

 $\frac{w1}{w2}=\frac{g1}{g2}=\frac{d1}{d2}=\sqrt{\frac{q1}{q2}}$

* + if approach width deduced from the above rule is less than of feeder road, it should be made equal to that of feeder road and the green time made corresponding less.
	+ Extra green time thus allocated to other phase results in less widening being necessary.
	+ Flow used should be the maximum flow on the 2 or more arms of the same phase.
		1. With multiple phase intersection

w1:w2:w3:…….:wn = $\sqrt{q1}$:$ \sqrt{q2}:\sqrt{q3}$:…..$ :\sqrt{qn}$

 = g1:g2:……:gn =d1:d2:…….:dn

* + 1. T – junctions with 2 phase control,

 $\frac{w1}{w2}=\sqrt{\frac{q1}{2 q2}}$ ; $\frac{g1}{g2}=\frac{d1}{d2}=\sqrt{\frac{2 q1}{q2}}$

 2 refers to stem of T-junction.

**Area Traffic Control:**

Introduction:

* Area traffic control is futhur extension of coordinated signal systems. Description of simple linked system along a single road.
* If works on same principle of coordination to include signals in a sustainable area.
* Area Traffic Control is technique through for a centralized control of numerous signal installation distributed through an urban area, such that there is a planned coordination b/w signals at different junctions. Technique invariable employs digital computers for achieving the desired.

Objectives:

* Minimizing journey time for vehicle.
* Reducing accidents
* Minimizing person time
* Minimizing vehicle stops, resulting less noise, less pollution and less consumption of fuel.
* Discouraging use of certain areas.

Traffic Control Methods:

1. Fixed time plans based on historical data and calculation off line by a computerized optimizing technique. Information movement is obtained manually on through detectors and fed to the computed which then determine the signal.
2. Coordinated system will response from at each signal,

Example: FLEXIPROG (Flexible Progressive) and EQUISAT (Equally Saturated).

1. Fully responsive system such as S.P.G (Signal Plan Generation).
2. **Road User Characteristics:**
	1. **Physiological** – Vision, hear
	2. **Psychological** – perception, Intellection, Emotion, Violation (**2.5 sec)**
3. **Speed –** Spot speed, Journey speed, Running Speed, Time mean speed, Space mean speed.
	1. **Methods of spot speed:**
		1. Time taken by a vehicle to cover distance
			1. Long distance
				1. Direct timing method
				2. Enoscope
				3. Pressure contact tube
			2. Short distance
		2. Radar method
		3. Photographic
	2. **Running and journey speed:**
		1. Moving observer
		2. Registration number method
		3. Elevated observer method
4. **Volume**
	1. **Needs**
	2. **Types of counts**
		1. Level of measurement
		2. Short term and long term
			1. Short term
			2. Daily volume count or counts for full day
			3. Counts for week
			4. Continuous counts
		3. **Methods**
			1. Manual
			2. Mannual and mechanical
			3. Automatic devices
				1. Electric plate
				2. Pneumatic tube
				3. Co-axial cable
				4. Radar
				5. Photo electric
				6. Infrared ultrasonic
				7. Magnetic
			4. Moving observer method
			5. Photographic method
5. **Origin and Destination:**
	1. **Needs**
	2. **Methods**
		1. Home interview
			1. Full interview technique
			2. Home questionnaire technique
		2. Registration number plate survey
		3. Postal survey
		4. Public transportation
		5. Road- side interview survey
		6. Tag on vehicle survey
	3. **Representation of data**
		1. Matrix
		2. Pictorial
6. **Vehicular characteristic**
	1. Braking system
	2. Dimensions and weights
	3. Acceleration and Deacceleration
	4. Lighting effect
	5. Types
	6. Features of the vehicle body
7. **Parking**
	1. Ill effects
	2. Prohibited parking
	3. Zoning and parking space requirement standards
	4. Common method on street parking
	5. Methods for off street parking
	6. Regulatory requirements for on street parking
	7. Peripheral parking
	8. Loading and unloading facilities
	9. Truck terminal
	10. Long distance travelling bus terminals
	11. Parking surveys
	12. Basic terms
8. **Signs**
	1. Importance
	2. Types
	3. Rms
	4. Principles
	5. Location, height & maintenance
9. **Signals**
	1. Advantages and disadvantages
	2. Signal indication
	3. Signal facilities
	4. No. of signals and locations
	5. Amber period
	6. Types of signals
	7. Determination of optimum cycle length and setting signs at intersections
	8. Saturation and right turning effects on saturation flow
	9. Warrants
	10. Signal approach dimensions
	11. Area Traffic control
	12. Coordinate control of signals
		1. Needs
		2. Objectives
		3. Types

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| ***(1). Average normal flow of a traffic on a cross roads A and B during design speed 400 and 200 pcu/hr. The saturation flow values are 1250 and 1000 pcu/hr. The all red time for pedestrian crossing is 12 sec. Design two phase traffic signals by WEBSTACH’s method?****Sol:* Saturation flow (S1) = 1250 pcu/hr Saturation flow (S2) = 1000 pcu/hr Design speed (q1) = 400 pcu/hr Design speed (q2) = 200 pcu/hr  Red time for pedestraining (R) = 12 sec Number of phases (n) = 2  Total lost time per cycle (L) = (l\*n) + R (assume l=2) = 2\*2 + 12 = 4+ 12  = 16 Optimum cycle length C0 = $\frac{1.5\*L+5}{1-Y}$ Where Y = Maximum ratio of flow to saturation flow   Y1 =$ \frac{q1}{S1}$ Y2 = q2/S2  Y1 =0.320 Y2 = 0.250 Y = Y1 + Y2 Y = 0. 320 + 0 .250 Y = 0.570  Gn= Yn/Y(C0 – L) Where G = Effective green time G1 = Y1 / Y (C0 – L) G2 = Y2/Y (C0 -L)G1 = 0.320/ 0.570 (67.442-16) G2 = 0.250/0.570 (67.442-16) G1 = 28.880 sec G2 = 22.562 sec ***(2). A T-junction has a design year flow 300 veh/hr on the south and 2400 veh/hr on the eastern and west arms. What should be the ratio of approach with lengths and green time of the arms?*** ***Sol.*** Given Data  Year flow q1 = 300 veh/hr  q2 = 2400 veh/hr$ \frac{W1}{W2}=\frac{g1}{g2}=\frac{d1}{d2} $=$\sqrt{\frac{q1 }{q2 }}$ $\frac{Ws}{Wes}$ =$\sqrt{\frac{q1 }{2\*q2 }}$ $\frac{g1}{g2}$ $=\sqrt{\frac{q1 }{q2 }}$ $ =\sqrt{\frac{300 }{2\*2400}} \frac{g1}{g2}$ =$\sqrt{\frac{2\*300}{2400}}$ = 1/4 = 1/2 $Ws$ : $Wes$ = 1:4 $g1$: $g2$ = 1:2***(3). 15 minutes traffic counts on cross roads 1 and 2 during peak hours are observed as 178 and 142 veh/lane respectively approaching the intersection in the direction of heavier traffic flow. If the amber time requires are 3 and 2 seconds respectively. For the two loads based on the approach speed. Design the signal timing by trial and error method average time headway as 2.5 seconds given green phase?*** ***Sol.***  Given data  q1 = 178 veh/hr q2 =142 veh/hrAmber time A1 = 3 secAmber time A2 = 2 secTime t= 15 min =15\*60 = 900 sec Average time Headway = 2.5***Trail No: 1*** Assume C0 = 50 sec Cycle = t/ C0 = 900/50 = 18 Green time g1 = q1/18 \*2.5 Green time g2 =q2/18 \* 2.5 = 178/18 \*2.5 = 142/18 \*2.5  = 24.723 sec = 19.722 secTotal cycle length = A1+A2+ g1+g2  = 2+3+24.723+19.722 = 49.445 sec***Trail No: 2***Assume C0 = 48 sec Cycle = 900/48 = 18.750 Green time g1 = q1/18.750 \*2.5 Green time g2 =q2/18.750 \* 2.5 = 178/18.750\*2.5 = 142/18.750\*2.5 =23.733 sec = 18.333secTotal cycle length = A1+A2+ g1+g2 = 2+3+23.733+18.333 = 47.066 sec***Trail No: 3***Assume C0 = 45 sec  Cycle = 900/45 = 20 Green time g1 = q1/20 \*2.5 Green time g2 =q2/20 \* 2. 5 = 178/20\*2.5 = 142/20\*2.5  = 22.250 sec = 27.750 sec Total cycle length = A1+A2+ g1+g2 = 2+3+22.250+17.750 = 45 sec |