Transportation Engg → I

Unit → 3

→ **Road User characteristics** ⇒ The human element is involved in all actions of the road users either as pedestrain, cyclist, cart driven or motorist. The Physical, mental and emotional characteristics of human beings effect their ability to operate motor vehicle safty or to service as a pedestrain.

The various factors which effect road user characteristics may broadly be classified:

① **Physical characteristics** ⇒ The physical characteristics of road users may be either permanent or temporary. The pavement characteristics are the vision, hearing, strength and the general reaction to traffic situations.

Vision ploys the most important role of all these. These include the a acuity of vision, Peripheral vision and eye movement; glare vision, glare recovery and depth judgement.

Hearing helps drivers in a way, though it is more important for pedestrains and cyclists. Though strength is not an important factor in general lack of strength may make parking

manoeuvers difficult, particularly for heavy vehicles.

Mental characteristics ⇒ Knowledge, skill, intelligence experience and literacy can affect the road user characteristics. Knowledge of vechile characteristics traffic behaviour, driving practice, rules of roads and psychology of road users will be quite useful for safe traffic operations.

Psychological Factors ⇒ These affect reaction to traffic situations of road users to a great extent The emotional factors such as attentiveness, Fear anger, superstition impatience, general attitude towards traffic and regulations and maturity also come under this

Environmental factors ⇒ The various environmental conditions affecting the behaviour of road user are traffic stream characteristics, facilities to the traffic, atmospheric conditions and the locality The traffic stream may consist of mixed traffic or heavy traffic whereas the facilities to overtake for faster vehicles may be limited.

→ **Vehicular characteristics** ⇒ It affects the design of road and traffic performance. The various vehicular characteristics affecting the road design may be classified as static and dynamic.

① **Static** ⇒ of the vehicles affecting road design are the dimensions, weight and max turning angle.

③

The height of vehicle affects the clearance of the overhead structures. The height of driver seat affects the visibility distance and the height of head light affects the light distance at valley curves.

② **Dynamic** ⇒ of the vechicles affecting road design are speed, acceleration and braking characteristics and some aspects of vehicle body design. The speed and acceleration depends upon the power of the engine and the resistances to be overcome and are important in all the geometric design elements.

③ **Vehicle dimensions** ⇒ The dimensions to be mainly considered are the overall width, height and length of different vehicles, particularly of the largest ones. The width of the vechile affects the width of the traffic lanes, shoulders and parking Facilities. Height of the vechile affects the clearance to be provided under structures such as over-bridges, under-bridges, electric and other service lines.

→ **Define Traffic volume** ⇒ Traffic volume is the number of vehicles crossing a section of road per unit time at any selected period. Traffic volume is used as a quantity measure of flow, the commonly used units are vehicles per day and per hour. The objective and uses of traffic volume studies are below.

(11)

① Traffic Volume study is used in planning, traffic operation and control of existing facilities and also planning and designing the new facilities.

② This study is used in the analysis of traffic patterns and trends.

③ Traffic volume is generally used as a true measure of the relative importance of roads and in deciding the priority for improvement and expansion.

④ Volume distribution study is used in planning one-way streets and other regulatory measures.

⑤ Turning movement study is used in the design of intersections, in planning signal timings, channelization and other control devices.

⑥ Pedestrain traffic Volume study is used for planning side walks, cross walks, subways and pedestrian signals.

→ Various speed characteristics of traffic

The actual speed of vehicles over a particular route may fluctuate widely depending on several factor such as geometric features, traffic conditions, time, place, environment and driver.

① Travel time is the reciprocal of speed and is a simple measure of how all well a road net-work is operating.

⑤

② **Spot Speed** ⇒ is the instantaneous speed of a vehicle at a specified section or location.

③ **Average Speed** ⇒ is the average of the spot speeds of all vehicles passing a given point on the highway. There are two definitions for average ie Space-mean speed or Time-mean speed

④ **The average travel time** ⇒ of all the vehicle is obtained from the reciprocal of space mean speed.

⑤ **Time-Mean Speed** ⇒ represents the speed distribution of vehicles at a point on the roadway and it is the average of instantaneous speed of observed vehicles at the spot.

$$Vt = \frac{\sum_{i=1}^{n} V_i}{n}$$

where = V_t = Time-Mean Speed
n = number of vehicles observed

⑥ **Runing Speed** ⇒ is the average speed maintained by a vehicle over a particular stretch of road, while the vehicle is in motion; this is obtained by dividing the distance covered by the time during which the vehicle is actually in motion.

⑦ **Overall Speed or travel Speed** ⇒ is the effective speed with which a vehicle traverse a particular route between two terminals; this is

⑥ obtained by dividing the total distance travelled by the total time taken including all delays and stoppages enroute.

7 **Origin and destination (O and D) Studies.**

The origin and destination (O and D) study is carried out mainly to (i) plan the road network and other facilities for vehicular traffic and (ii) plan the schedule of different modes of transportation for the trip demand of commuters.

The O & D study of vehicular traffic determines their numbers, their origin and destination in each zone under study. Origin and destination study gives informations likes actual direction of travel, selection of routes and length of the trip.

The various applications of O and D studies may be as follows:

① To judge the adequacy of existing routes and to use in planning new network of roads.

② To plan transportation system and mass transit facilities in cities including routes and schedules of operation.

③ To locate expressway or major routes along the desire lines.

④ To locate terminals and to plan terminal facilities.

⑦

⑤ To locate new bridge as per traffic demands.

⑥ To locate intermediate stops of Public transport.

⑦ To establish design standards for the roads, bridges and culverts along the route.

Parking Studies :- The demand of automobile users of parking space is one of the majors problems of highway transportation especially in metropolitan cities. In industrial commerical and residential places with multi-storyed buildings, parking demand is particularly high. Parking studies are useful to evaluate the facilities available.

Various aspects to be investigated during Parking Studies are:

① **Parking demand** :- The parking demand may be evaluated by different methods. One of the methods is by making cordon counts of the selected area and recording accumulation of vehicles during peak hours by subtracting the outgoing traffic from the traffic volume entering the cordoned area.

② **Parking characteristics** :- The study is directed to note the present parking practices prevalent in the area under consideration and the general problem in parking. In case of kerb parking, it is also necessary to study

(2) the parking patterns, interference to smooth flow of traffic and the accidents involved during parking and unparking operations.

(3) Parking space inventory ⇒ The area under study is fully surveyed and a map is prepared showing all places where kerb parking and off-street parking facilities can be provided to meet the parking demands. The traffic engineer has to strike a balance between capacity and parking demands and to design proper facilities for parking

→ accident studies ⇒ The problem of accidents is very acute in highway transportation due to complex flow patterns of vehicular traffic, presence of mixed traffic and pedestrians. Traffic accidents may involve property damages, personal injuries or even casualities. One of the main objectives of traffic engg is to provide safe traffic movements.

The various objectives of the accident studies may be listed as:

(1) To study the causes of accidents and to suggest corrective treatment at potential location.

(2) To evaluate existing designs.

(3) To support proposed design.

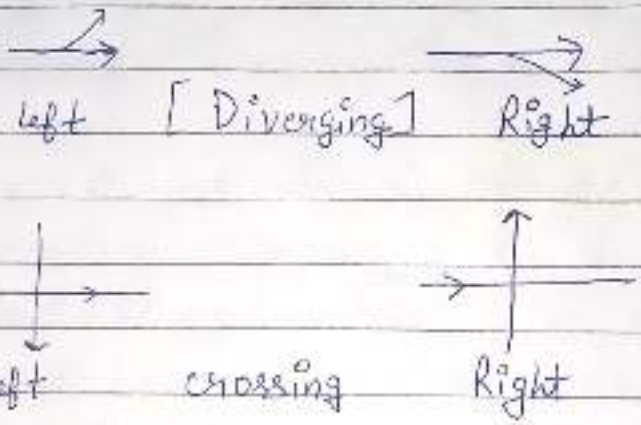
(4) To make computations of financial loss

(9)

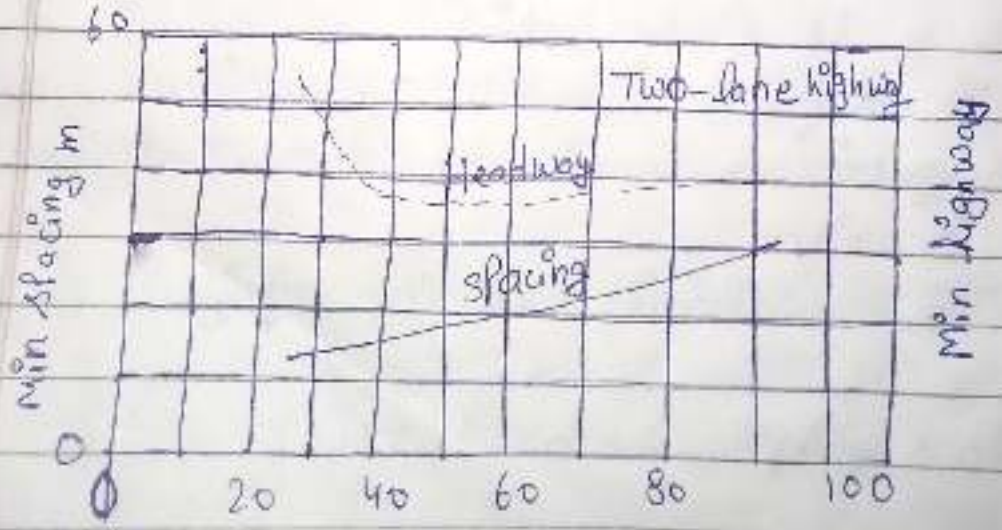
(3) To carry out before and after studies and to demonstrate the improvement in the problem.

⇒ **Traffic Flow characteristics**

Traffic stream generally has flow and counter flow along a common route, unless the stream is separated into pair of one-way flows by proper design or regulations.



The crossing traffic is the greatest problem in case of road intersections at level because vehicles on one road have to stop before allowing stream of vechicles to cross their path.



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→ Traffic Volume :- is the number of vehicles moving in a specified direction on a given instant, ~~usually expressed~~ lane or roadway the pass a given point or cross section during specified unit of time.

→ Traffic density :- is the number of vehicles occupying a unit length of lane of roadway at a given instant usually expressed as vehicles per kilometer. Traffic volume is the product of the traffic density and Traffic Speed.

→ P.C.U (Passenger car unit)

Different classes of vehicles such as cars, Vans, buses, trucks, auto rickshaw, motor cycles, pedal cycles bullock carts etc. are found to use the common road way Facilities without segregation on most most of the roads in developing ~~vehicle flows on~~ countries like India.

PCU :- Thus in mixed traffic flow, the traffic volume and capacity are generally expressed as PCU per hour or PCU/lane/hour and the traffic density as PCU per kilometer length of lane.

Factor affecting PCU values :- ① Vehicles characteristics such as dimension, Power, speed acceleration and braking characteristics.

② Transverse and longitudinal gaps or clearance b/w moving vehicles which depends upon the speed.

(3) Traffic stream characteristics such as composition of different vehicles classes, mean speed or speed distribution of the mixed traffic stream.

(4) Environmental and climate conditions.

→ **Various causes of road accidents**

(1) **Drivers** ⇒ Excessive speed and rash driving, carelessness, violation of rules and regulations, Failure to see or understand the traffic situation, sign or signal.

(2) **Pedestrains** ⇒ Violating regulations, carelessness in using the carriageway meant for vehicular traffic.

(3) **Passengers** ⇒ Alighting from or getting into moving vehicles.

(4) **Vehicle defects** ⇒ Failure of brakes, steering system or lighting system.

(5) **Road condition** ⇒ Slippery or skidding road surface, pot holes ruts and other damaged.

(6) **Road design** ⇒ Defective geometric design like inadequate sight distance inadequate width of shoulders, improper curve design, improper lighting. A

(12)

Various Traffic Signals

Traffic Signals ⇒ At intersection where there are a large number of crossing and right turn traffic there is possibility of several accidents due to lack of orderly movements. The decision to install an automatic traffic control signal must be based on careful analysis of the existing traffic data and non sound engineering judgment. The period of time required for one complete sequence of signal indications is called cycle.

Type of traffic Signals

1. Traffic control Signals
2. Pedestrain Signals
3. Special traffic Signal

(1) **Traffic Control Signals** ⇒ The Traffic control Signals have three coloured light glows Facing each direction of Traffic Flow. The red light is meant for stop, the green light indicate Go and the amber or yellow light allows the clearance time for the vehicles which enter the intersection area by the end of green time to clear off. Traffic controls signals are of two types.

(i) **Fixed-time signal** ⇒ are set to repeat regularly a cycle of red, amber and green light. The timing of each phase of the cycle is predetermind

(13)

based on the Traffic studies and they are the simple type of automatic traffic signals which are electrically operated.

(ii) **Traffic actuated Signals** ⇒ are those in which the timings of the phase and cycle are changed according to traffic demand. In Semi-actuated traffic signals the normal green phase of an approach may be extended upto a certain period of time for allowing a few more vehicles approaching closely.

→ **Traffic control devices** ⇒ The various aid and devices used to control, regulate and guide traffic are be called traffic control devices. The most common among this

1. Signs
2. Signals
3. Marking
4. Islands.

→ **Traffic Signs** ⇒ Traffic signs have been divided into three categories according to Indian Motor Vehicles Act.

① Regulatory signs
② Warning signs
③ Informatory

① **Regulatory Signs** ⇒ Regulatory or mandatory signs are meant to inform the road

users of certain laws, regulations and prohibitions the violation of these sign is a legal offence. The regulatory signs are classified under the following sub-heads.

(i) The stop sign and give way sign
(ii) Prohibitory signs
(iii) No Parking sign and no stopping sign
(iv) Speed limit Signs
(v) Restriction ends sign
(vi) Compulsory direction control sign

(2) **Warning signs** :- Warning or Cautionary signs are used to warn the road users of certain hazardous conditions the exist on or adjacent to the roadway. The warning signs are in the shape of equilateral triangle with its apex pointing upwards. They have a white background, red border and black symbols. The commonly used Warning signs are, Right Hand / Left hand curve, right / left air pin bend, Right / Left Reverse Bend, Steep Ascent / Descent. Narrow Bridge / Road Ahead, Gap in Median, slippery Road, cycle crossing, Pedestrain Crossing School Zone.

(3) **Informatory Signs** :- These signs are used to guide the road users along routes, inform them of destination and distance and Provide with information to make travel easier

(15)

Safe and pleasant. The information signs are grouped under the following sub-heads:

① Direction and Place identifications signs
② other useful information signs
③ Facility / information signs
④ Parking signs
⑤ Flood gauge

7 Write down the design of Isolated Fixed time signals by IRC method.

In the design of a Isolated Fixed time signal or signalized intersection. The objective should be to provide sufficient capacity for the volume of traffic approaching the intersection. The design should aim at minimizing total delay, building short queues, and providing a high probability of passing through the intersection.

The design procedure of Isolated Fixed time signal by IRC method is given below:

① The pedestrain green time required for the major and minor roads are calculated based on walking speed of 1.2 m/sec. and initial walking time of 7.0 secs. These are the min green time required for the Vehicular traffic on the minor and major roads respectively.

(16)

(ii) The green time required for the vehicular traffic on the major road is ↑ in proportion to the traffic on the two approach roads.

(iii) The cycle time is calculated after following amber time of 2.0 secs, each.

(iv) The min green time required for clearing vehicles arriving during a cycle is determined for each lane of the approach road assuming that the first vehicle will take 6.0 sec.

(v) The Signal cycle time and the Phases May be revised keeping in view the green time required for clearing the vehicles and the optimum cycle length determined.

→ Basic requirement of intersection at grade

(1) At the intersection, the area of conflict should be as small possible.

(2) The relative speed and particularly the angle of approach of vehicle should be small.

(3) Adequate visibility should be available for vehicles approaching the intersection.

(4) Sudden change of path should be avoided.

(5) Good lighting at night is desirable.

(17)

⑥ Proper Signs should be provided on the road approaching intersection to warn the drivers.

Types of grade intersection:

① Unchannelized ⇒ The intersection area is paved and there is absolutely no restriction to vehicles so use any part of intersection easiest in the design; but most complex in traffic operations resulting in max conflict area and more number of accidents unless controlled by traffic signals or police. when no additional pavement width for turning movement is provided it is called intersection.

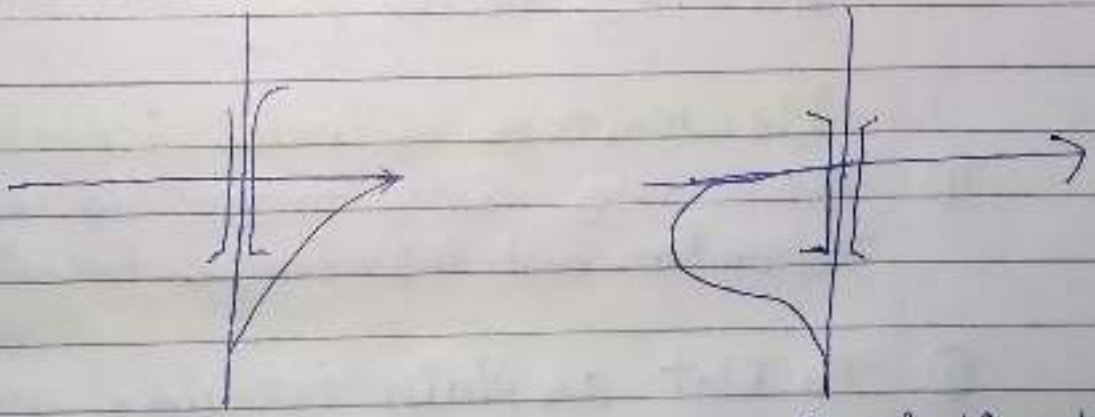
② channelized intersections ⇒ Channelized intersection is achieved by introducing islands into the intersectional area, thus reducing the total conflict area available in the unchannelized intersections. The radius of the entrance and exit curves and the area are suitably designed to accommodate the channelized islands of proper size and shape.

③ Rotary intersections ⇒ A rotary intersection or traffic rotary is an enlarged road intersection where all converging vehicles are forced to move round a large central island in one direction

(clockwise direction) before they can weave out of traffic flow into their respective directions radiating from the central island. The main objects of providing a rotary are to eliminate the necessity of stopping even for crossing streams of vehicles and to reduce the area of conflict.

⇒ Grade Separated intersections

Grade separated intersection design is the highest form of intersection treatment. This type of intersection causes least delay and hazard to the crossing traffic and in general is much superior to intersections at grade from the point of view of traffic and efficient operation. A highway grade separation is achieved by means of vertical level. Separation of intersecting roads by means of a bridge thus eliminating all crossing conflicts at the intersection.



Direct Semi-direct

Interchange Ramps

(19)

Advantages of Grade Separation

① Min Facility is given to the crossing traffic. As the roads are separate. this avoids necessity of stopping and avoids accidents while crossing.

② The overall increase in comfort and convenience to the motorists and Saving in travel time and vehicle operation cost.

③ The capacity of the grade separated intersection can practically approach that of the two cross roads.

④ Grade separation is an essential part of controlled ~~acc~~ access highway like expressway and Freeway.

⑤ It is possible to adopt grade separation for all likely angles and layout of intersecting roads.

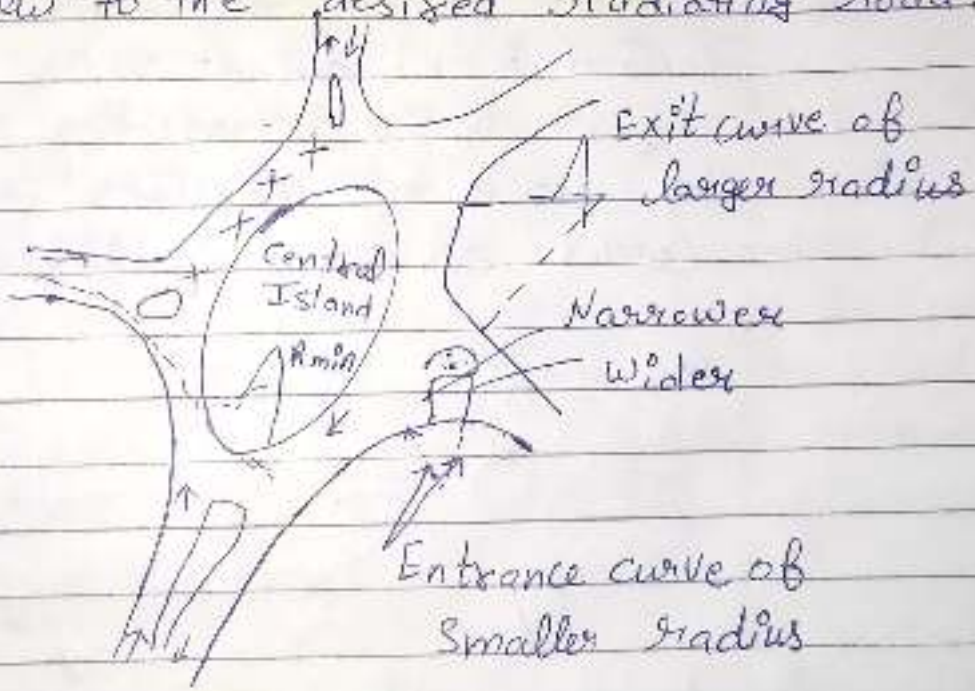
Disadvantage of Grade Separation

① It is very costly to provide complete grade Separation and interchange Facilities.

② In Flat or plain terrain, grade separation May introduce undesirable crests and sags in the vertical alignment.

Design of a rotary

A rotary intersection or traffic rotary is an enlarged road intersection where all converging vehicles are forced to move round a large central island in one direction before they can weave out of traffic flow into their respective directions radiating from the central islands. The main objects of providing a rotary are to eliminate the necessity of stopping even for crossing streams allowing all vehicles to merge into the crossing around the rotary and then to diverge out to the desired radiating road.



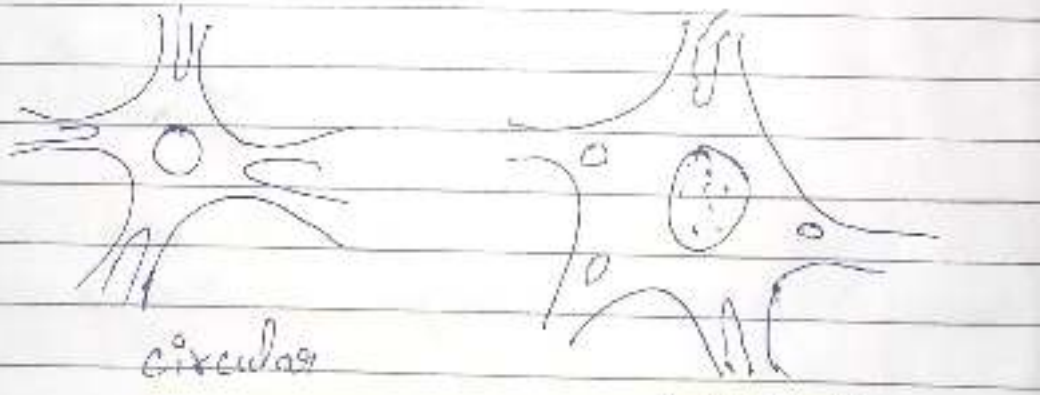
Design Factors of Rotary:

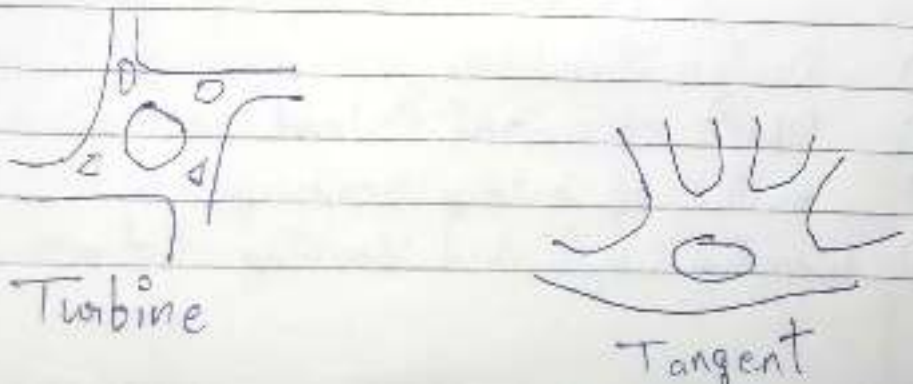
1. Design Speed
2. Shape of central island
3. Radius of rotary roadway
4. Weaving angle and weaving distance

(21)

(1) **Design Speed** ⇒ Vehicles approaching at intersection at grade have to considerably slow down their speed when compared to the design speed standard of the highway under consideration. Though there is no need for vehicles in a traffic rotary to come to a dead stop before allowing cross traffic to cross, still there has to be considerable reduction in speed. In all other cases and for rotaries in urban areas a speed of 30 kmph is adopted for design.

(2) **Shape of central island** ⇒ The shape of the central island depends on the number and the layout of the intersecting roads. The outline of the island consists of a number of curves of large radii, without corners.





(3) **Radius of rotary roadway** ⇒ The one-way rotary road around the central island has different radii at different points depending on the shape of the central island. Adequate superelevation cannot be provided on the rotary roads and hence it is safer to neglect the superelevation and to take friction only into consideration.

(4) **Weaving angle and weaving distance** ⇒ The angle between the path of a vehicle entering the rotary and that of another vehicle leaving the rotary at adjacent road, thus crossing the path of the former is termed as the weaving angle.

(5) **Width of carriageway at entry and exit** ⇒ The carriageway width at the entrance and exit of a rotary is governed by the amount of traffic entering the rotary from the road or that leaving the rotary to the road. The min width of carriageway at the entrance and exit should be 5.0m width may be increase to 6.5 to 7.0 and 8.0m.

(6) **Entrance and exit curves** ⇒ The curve traced by the inner rear wheel of vehicles determines the radius and shapes to which the kerb line is to be set. A vehicle entering a rotary has to slow down to the design speed of the rotary and therefore the radius. For the design speed of 40 kmph the suggested at entry curves

(23)

is 20 to 35m and for 30kmph, 15 to 25m.

(7) Capacity of the rotary :- The practical capacity of the rotary is dependent on the min capacity of the individual weaving section

$$Q_R = \frac{208 W (1 + e/W)(1 - P/3)}{(1 + W/L)}$$

Where, Q = Practical capacity of the weaving section of a rotary in per hour

W = width of weaving section (6 to 18m)

e = average width of entry

w.r. range e/w = 0.4 to 1.0

P = Proportion of weaving traffic

$$P = \frac{b + c}{a + b + c + d}$$ in range 0.4 to 1.0

The IRC has recommended the following PCU values for finding the capacity of the rotary.

(1) Cars, light commerical vehicles and three wheelers = 1.0

(2) Buses, medium and heavy commercial vehicls = 2.8

(3) Motor cycles, scooters = 0.75

(4) Pedal cycles = 0.50

(5) Animal drawn vehicles = 4 to 6

(8) **Camber and Super elevation** :- A vehicle passing along a rotary traverses a reverse curve while changing from one-way path of roadway to the exit of the radial road. Hence the cross slope of the rotary roadway at the point of change in direction should be minimum.

(9) **Sight distance, grade** :- The sight distance in the rotary should be as large as possible and in no case less than the safe stopping distance for the design speed. The minimum sight distance should be 45 and 30m for design speed 40 and 30 kmph.

(10) **Lighting** :- The minimum light required is one each on the edge of central island facing each radiating road. Point A in Fig. Additional light 'B' may be provided when the central island is larger than 60mm dia. Light 'C' may also be provided near the entrance curve if the pedestrains are large in number.

(11) **Traffic Sign** :- The standard Traffic signs indicating the presence of rotary intersection should be installed at all approaching roads to give advance information to traffic. Vertical black and white strips of width 25 to 30 cm painted on kerb.