CASE STUDY ON TRAFFIC ROTARY –SATWARI JAMMU

[1]Gurmeet Singh, [2]Sahil Kumar Gupta

[1]Assistant Professor, [2]Assistant Professor
[1,2]Civil Engineering Department, Government College of Engineering and Technology, Jammu, India

---

ABSTRACT: *The road traffic is composed of different categories of vehicular traffic and pedestrian traffic. Each category of vehicular traffic has two components, the human element as the driver and the machine as the vehicle. Traffic engineering has also to be recognized and governed by social and physical science. The traffic in India and other developing countries of the world is heterogeneous in nature. The available road space is occupied by different classes of vehicles with widely varying characteristics. The vehicles that share the same roadway space include motorized and non-motorized vehicles. Many of the urban roads are congested during peak hours, causing delay, accidents and reduced travel speed of the vehicles.*

The problem becomes more complicated as the road space is shared by pedestrians also on several roads. In India, unfortunately at the planning and design stages, the pedestrians are not considered as an element in road traffic; the pedestrian is often considered as an intruder in the traffic stream by the drivers of motorized traffic. As a result, pedestrians contribute a significant proportion of fatal accident victims in the country.

This project report describes about details of ***CASE STUDY OF A TRAFFIC ROTARY.*** *In this case study, Jammu city has been selected as case study area. The SATWARI intersection is major area of concern. It is considered as one of the major uncontrolled intersections in Jammu. The performance of this intersection is investigated during peak hours and then the provisions are to be made for present and future.*

In this report, we have discussed about the problems encountered at the site, importance of this rotary junction, geomatics of the rotary intersection and the recommendations that are to be made are also included with reference to the Indian standards.

CHAPTER 1- INTRODUCTION

1.1 OBJECTIVE

In this project report, we have to deal with all the aspects of a rotary intersection such as the types of rotaries and the geometric design. Then, we have to proceed with respect to our site so that all the details about the rotary intersection can be calculated and necessary provisions are made.

For this purpose, the following objectives are:

1) Field survey.
2) Finding out the capacity of rotary intersection.
3) Visual inspection of traffic at peak hours.
4) Analyzation of survey data.
5) To provide suggestion for modification of the rotary-if required.
6) To make provision for some traffic control measure.

In this case study, Jammu city has been selected as case study area. The SATWARI intersection is major area of concern. It is considered as one of the major uncontrolled intersections in Jammu. The performance of this intersection is investigated during peak hours and then the provisions are to be made for present and future.

1.2 STREAMLINING THE TRAFFIC: For the proper functioning of the traffic rotaries, the traffic should be streamlined. In countries like India, 'keep to left' regulation is being followed and the vehicles are designed with steering wheel placed on the right side and therefore the vehicles are expected to move along the left lane of the carriageway. The basic manoeuvres in traffic stream is defined through Diverging, Merging, Crossing & Weaving manoeuvres.

Diverging: When a vehicle travelling along the main traffic stream opts to diverge or move out of this stream to an adjacent traffic lane to a side road, this operation is called 'diverging manoeuvre'. Since diverging to the left doesn't create a conflict, but diverging to the right does. Therefore, a vehicle diverging to the right has to wait for adequate gap in the counter flow of the main stream.

Merging: When a vehicle travelling along an adjoining lane or roadway desires to enter the main traffic stream by looking for an opportunity of sufficient gap between the vehicles of the main stream, this operation is called 'merging manoeuvre' and the vehicles have to wait before merging till a sufficient gap is created to avoid the conflicts.

Crossing: The crossing manoeuvre is of great concern to the traffic engineer in the case of road intersections at the same level, as there is possibility of a major conflict or collision between the crossing vehicles. In order to avoid the collision, the vehicles on the one road have to stop for allowing the crossing stream of vehicles to move. Thus on Intersections at grade or cross roads, the traffic flow is possible on one road at a time, resulting in the considerable reduction in the capacity of the intersections; the capacity of intersection at-grade practically reduces to less than that of the any of the two cross roads.

Weaving: When a vehicle obliquely across the path of another vehicle moving in the same direction at relatively small angle of crossing. The manoeuvre is termed as 'weaving'. The weaving manoeuvre may also be considered to consist of two vehicles of ajoining lanes making 'lane changes' or merging and diverging operations along a short stretch

Factors affecting stream flow

1. Vehicles travelling at different speeds of their choice
2. Different types and classes of vehicles travelling along the same stream
3. Presence of pedestrians and other road users
4. Geometric features of the roads including the different types of intersections
5. Various types of regulatory and control measures
6. Environmental and weather conditions

1.3 WHY THIS ROTARY?

Satwari is one of the busiest roundabout located on the surroundings of Jammu-Tawi. Many commercial and industrial activities happen here. The land use is not concentrated in a particular area. The satwari rotary heads towards four directions:

1. **To/From Jammu End:** Most of the traffic is generated on this portion. Since every kind of traffic prevails in this portion, there's been a chaotic situation in peak hours.
2. **To/From Kunjwani End:** This portion consists of heavy vehicle and passenger vehicles since they are heading towards an industrial area.
3. **To/From Airport:** This portion which heads towards the airport consists of VIPs and other Higher Officials, And much of the important tasks may get affected by this problem of traffic congestion.
4. **To/From Army Cantonment:** This portion has not any severe traffic problem but the culture of Army convoy passing creates traffic problems

Keeping this fact in mind, we have considered this place as a case study area. Location is selected on the basis of intensity of usefulness and poor traffic conditions by visual survey.

Overview of rotary design

CHAPTER 2- LITERATURE REVIEW

2.1 Definitions

1. **ROTARY ISLAND:** A traffic island located in the centre of the intersectionnto compel the movement in the clockwise direction and thus substitute weaving of traffic around the island instead of direct crossing of vehicle pathways.
2. **ROTARY INTERSECTION:** A road junction laid out for movement of traffic in one direction around a central island.
3. **AT-GRADE INTERSECTION:** An intersection where all the roadways join or cross each other.
4. **DIVERGING:** Dividing of single stream of traffic into separate streams.
5. **INTERSECTION ANGLE:** The angle between two intersection legs.
6. **MERGING:** The converging of separate stream of traffic into a single stream of traffic.
7. **WEAVING:** The combined movement of merging and diverging of traffic streams moving in the same general directions.
8. **WEAVING LENGTH:** The length of a section of a rotary in which weaving occurs.

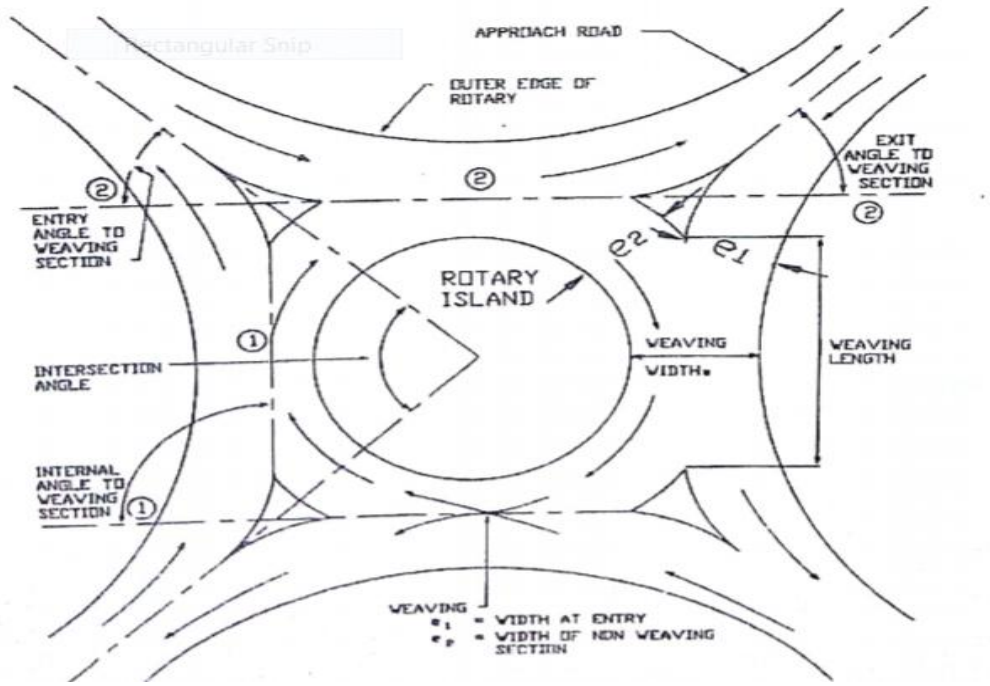

Fig 1- Rotary Elements

Advantages of rotary intersections

1. An orderly and regimented traffic flow is provided. Individual traffic movements are subordinated in favour of traffic as a whole.
2. All traffic proceeds as a fairly uniform speed. Frequent stopping and starting are avoided.
3. Weaving replaces the usual crossing at typical at grade intersections. Direct conflict is eliminated, all traffic merging or diverging at small angles. Accidents occurring due to this are of very minute nature
4. Rotaries are especially suited for intersection with five or more intersection legs though these can also be adopted at intersections with three or four legs.
5. For moderate traffic, rotaries are self governing and need no control by police or traffic signals.

Disadvantages of rotary intersection

1. As the flow reaches their capacity, 'weaving' generally gives the way to a 'stop and motion' as vehicles force their way into the rotary, being followed by the vehicle in their in a queue behind them. Under such conditions, vehicles once having got into the rotary, may not be able to get out of it. Because of the vehicles across their path and the

rotary may lock up. The movement of vehicles completely stops and the taffic will have to be ultimately sorted out by the police.
2. A rotary requires a larger area and may not be feasible in a built-up location.
3. Where pedestrian traffic is large, the rotary may not be able to handle the traffic by itself and has to be supplemented by police.
4. When the angle between the two intersections is too acute, the it is very difficult to provide adequate weaving length.
5. The provisions of rotaries at close intervals make travel troublesome.
6. Traffic turning towards right has to travel a little extra distance.

2.2 Guidelines for selection of rotary intersections

Considering the above advantages and disadvantages of traffic rotaries and the general experience gained in their provision in this country and abroad, the following general guidelines may be kept in view when adopting a rotary design at intersection:

1. Circumstances where rotaries are an appropriate method of intersection control are largely independent on the layout of the site, proportion of the right turning traffic and the traffic characteristics of the routes. Rotaries are not adopted for intersection carrying very light traffic. These could be good choice for moderately busy intersections in urban and sub-urban areas, and also for rural areas sometimes. Normally, the lowest traffic volume for which the traffic rotary design is adopted is 500 vehicles/hour.
2. Rotaries are most adaptable where the volumes entering the different intersection legs are equal.
3. The maximum value that a traffic rotary can handle efficiently can be taken as about 3000 vehicles/hour, entering from all intersection legs.
4. Rotaries are advantageous in locations where proportion of right turning traffic at a junction is high. As a rough guide, it may be assumed that at a four legged junction, a rotary is more justified than traffic signal control if the right turning traffic exceeds about 30% pf the approaching traffic.
5. A rotary is preferable if there are junctions so nearby that there is insufficient space for the formation of queue.

2.3 Shape of Rotary Island

The shape of the rotary island depends on various factors such as the number and disposition of the intersecting roads and the traffic flow pattern. The design of the rotary is developed by connecting the one-way entrance and the exit roads to form a closed figure with atleast the minimum weaving lengths interposed between two intersecting legs and then adjusting for the minimum radius of the rotary corresponding to the design speed. In doing so, it may be necessary to try out a number of alternatives, before selecting the best. While finalizing the shape of the rotary island, traffic streams within the rotary should be should be given dominance over the streams of traffic entering from different roads. Asymmetric shapes, either wholly curved or with a combination of straight and curves may often provide the only satisfactory solution. The possibility of realigning one or more of the intersecting legs could also be considered to achieve the minimum weaving lengths and the desired intersection angles. Some of the most common shapes of the rotary islands are discussed below:

Circular: A circular shape is suited where roads of equal importance intersect at nearly equal angles and carry nearly equal volume of traffic. Under these conditions, a constant and regular flow is achieved.

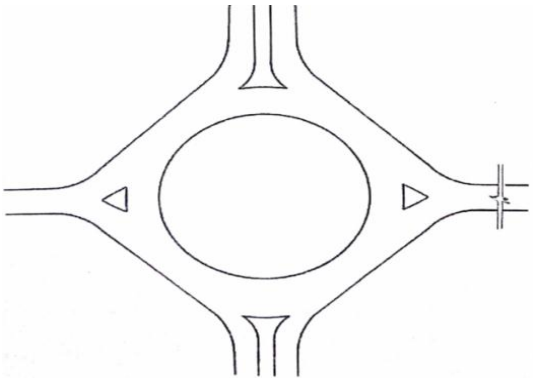

Fig 2-Circular Shaped Rotary

Squarish with rounded edges: This is a modification of the circular shape and is composed of four straights or four large radii curves roughly forming four sides of a square and four small radii curves at the corners. The advantage of this layout is that it is suitable for predominantly a head flow.

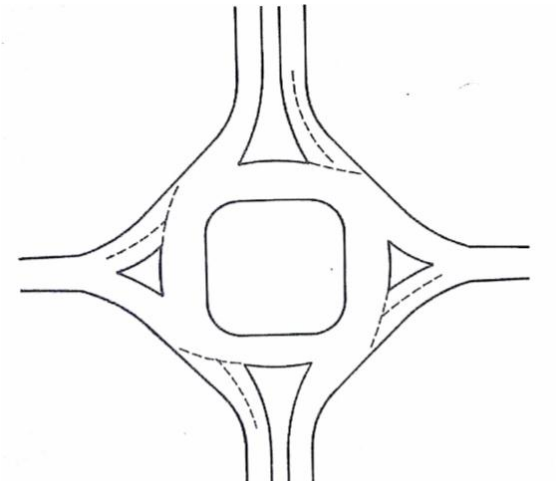

Fig 3- Squarish Rotary with Rounded Edges

Elliptical, Elongated & Rectangular: These shapes are provided to favour through traffic, to suit the geometry of the intersecting legs, or to provide a longer weaving length.

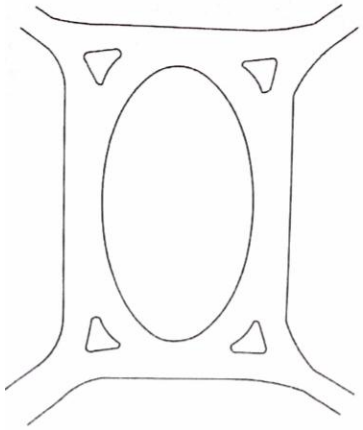

Fig 4-Elliptical Rotary

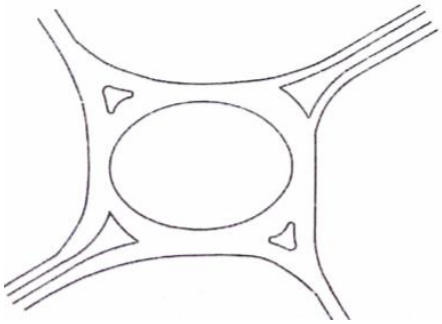

Fig 5-Rectangular shape

Complex Intersection with many approaches: This figure gives a layout of a complex intersection whose shape is dictated by the existence of a large number of approaches.

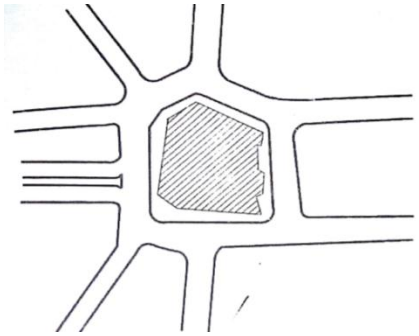

Fig 6-Complex Intersection

2.4 Radii of curves at entry and exit:

At entry

Radius of the curve at the entry is related basically to the design speed, amount of superelevation and the coefficient of friction. Since major intersections like rotaries are provided with advance information signs and drivers travel through them with anticipation of more critical conditions than on the open highways, the value of coefficient of friction for purpose of design are regarded as higher than for other locations. Based on overall considerations, the following table gives us the range of values for the radius of curves.

Table 1: showing radius of the rotaries

Rotary design speed (Kmph)	Suggested values for radius at the Entry
40*	20m-30m
30**	15m-25m

** speed generally suitable for rotaries in urban areas.

*speed generally suitable for rotaries in rural areas.

At exit

Theoretically, the radius at the exit should b larger than at the entry so as to encourage the drivers to pick up the speed and clear away the traffic. Therefore, the radius at the exit curves is kept 1.5 to 2 times the radius of the curves at the entry. However, there is a large pedestrian traffic across the exit road. Radii similar to those at entrances should be provided to keep the exit speeds reasonably low.

2.5 Radius of central island

Theoretically, the radius of the central island should be equal to the radius at entry. In practice, however, the radius of the central island is kept slightly larger than that of the curve at the entry, this being an attempt to give a slight preference to the traffic already on the rotary and to slow down the approaching traffic. A value of 1.33 times the radius of entry curve is suggested as a general guideline for adoption.

2.6 Weaving length

The weaving length determines the case with which the vehicles can manoeuvre through weaving section and thus determines the capacity of the rotary. The weaving length is decided on the basis of the factors such as the width of the weaving section, the average width of the entry, total traffic and the proportion of weaving traffic in it. As a general rule, effort should be made to keep the weaving length atleast 4 times the width of the weaving section.

Design speed(Kmph)	Min. weaving length (metres)
40	45
30	30

Table 2- Weaving lengths for the design speeds

In order to discourage speeding in the weaving sections, the maximum weaving length should be restricted to twice the values given above.

2.7 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 and leaving the rotary. When deciding upon the width, the possible growth of traffic in the design period should be considered. It is recommended that the minimum width of the carriageway be atleast 5 metre with necessary widening to account for the curvature of the road.

Carriageway width of the approach road (metres)	Radius at entry (metres)	Width of the carriageway at entry and exit (metres)
7m (2 lanes)	25m-35m	6.5
10.5m (3 lanes)		7.0
14m (4 lanes)		8.0
21m (6 lanes)		13.0
7m (2 lanes)	15m-25m	7.0
10.5m (3 lanes)		7.5
14m (4 lanes)		10.0
21m (6 lanes)		15.0

Table 3- Width of carriageway at entry and exit

2.8 Width of rotary carriageway

Width of non weaving section

The width of non weaving section of the rotary should be equal to the widest single entry into the rotary and should generally be less than the width of the weaving section.

Width of the waving section

The width of the weaving section of the rotary should be one lane wider than the mean entry width.

$W = (e_1+e_2)/2 + 3.5$

Where w= width of the weaving section.

And e_1= width at entry.

And e_2= width of the non weaving section.

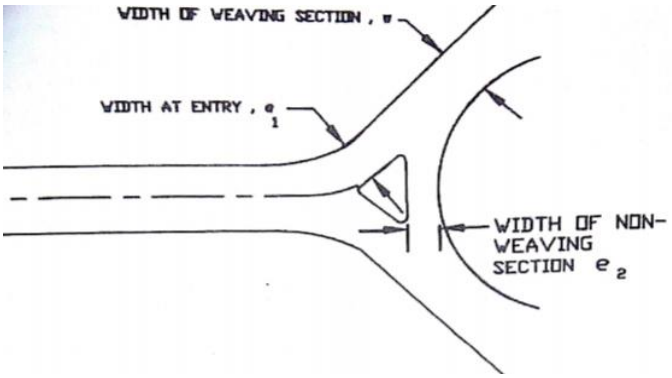

Fig 7- Width of Rotary Carriageway

2.9 Entry and Exit Angles

Entry angles should be larger than exit angle, and it is desirable that entry angles should be 60^0 if possible. The exit angles should be small, even tangential. An idealized having entry angles of 60^0 and exit angles of 30^0 can only be achieved by staggering the approach roads.

2.10 Capacity of the rotary

It is important that the geometric design evolved for the rotary should be able to deal with the traffic flow at the end of the design period of the rotary. The practical capacity of the rotary is really Synonymous with the capacity of the weaving section which can accommodate least traffic. Capacity of the individual weaving sections depends on factors such as:

1. Width of the weaving section.
2. Average width of entry into the rotary.
3. The weaving length.
4. Proportion of the weaving traffic.

Q_p= [280w(1+e/w)(1-p/3)]/(1+w/l)

Where Q_p= practical capacity of the rotary in P.C.U /hour.
W= width of the weaving section in metres.
E= average entry width in metres so that e/w= 0.4-1.0.
L= length of the weaving section in metres so that w/l= 0.12-0.4.
P= weaving ratio i.e ratio of crossing streams to the total traffic (0.4-1.0).

Car and Lmv	1.0
Buses and trucks	2.8
Motorized two wheelers	0.75
Pedal cycle	0.5
Animal drawn vehicles	4-7

Table 4- P.C.U conversions

The following adjustments in the capacity calculated by the above formula are suggested:

1. Where the entry angle is between 0^0-15^0, deduct 5% from the capacity of the weaving section.
2. Where the entry angle is between 15^0-30^0, deduct 2.5% from the capacity of the weaving section.
3. Where the exit angle is between 60^0-75^0, deduct 2.5% from the capacity of the weaving section.
4. Where the exit angle is greater than 75^0, deduct 5% from the capacity of the weaving section.
5. Where the internal angle is greater than 95^0, deduct 5% from the capacity of the weaving section.
6. Where the pedestrian flow at exit from the roundabout exceeds 300/hour, an arbitrary deduction of $1/6^{th}$ should be made in the practical capacity of the proceedingnweaving section.

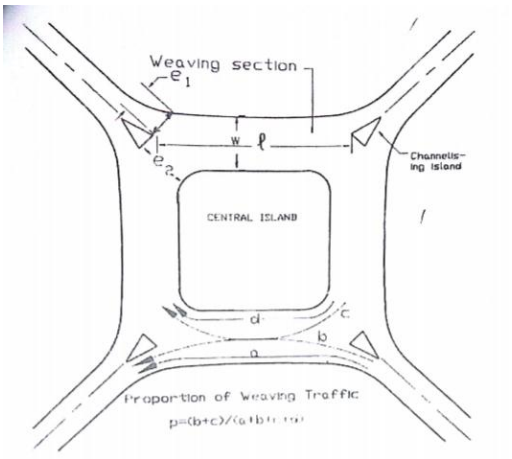

Fig 8- Rotary Elements

While designing care should be exercised that weaving sections are adequate for the required capacity so that merging and diverging manoeuvres take place smoothly. As a major disadvantage with the rotaries is the reduction of the speed. The weaving sections should preferably be kept slightly longer than just necessary for capacity say 33% to 50% more.The capacity of the rotary can be increased above the value by signalizing it.

2.11 Channelizing Islands

Channelization reduces the area of conflict between intersecting traffic streams and promotes orderly and safe movement. Channelizing islands must be provided at the entries and exits of a rotary. The shape of the channelizing island depends on the actual conditions obtaining at each site.

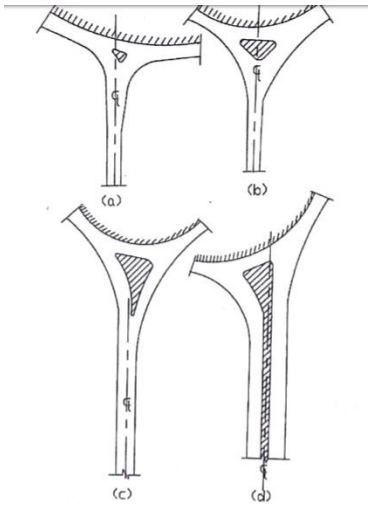

Fig 9-Shape of Channelizing Islands

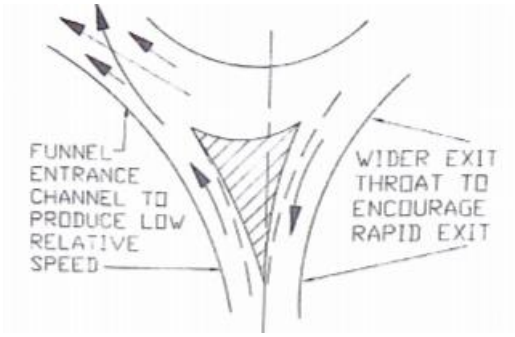

Fig 10-Channelizing island with funnel Entrance and wider throat

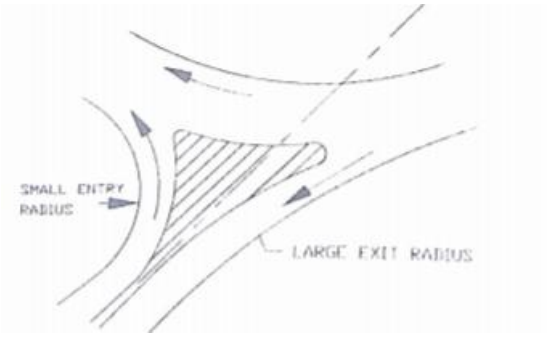

Fig 11-Channelizing Island with skewed Entry and exit

2.12 Outer Curb line

The external curb line of weaving sections should not normally be re-entrant, but consist of a straight or large radius curve of the same sense as the entry and exit curves. Such an arrangement eliminates waste of the area which is not likely to be used by the traffic.

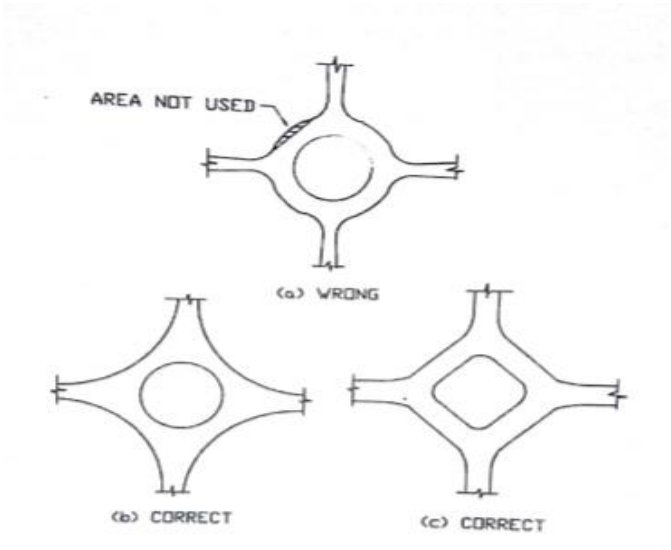

Fig 12- External curb line for Weaving Sections

2.13 Sight Distance

On approaching the rotary, the sight distance available should enable a driver to discern the channelizing and rotary islands clearly. A stopping sight distance appropriate to the approach speed should be ensured.

On the rotary itself, the sight distance should be adequate for the vehicles first entering a rotary to see vehicles to their right at a safe distance. Similarly, once a vehicle is on a rotary in the middle of a weaving section, it should be possible for it to see another vehicle ahead of it in the next weaving section at a safer distance. In both the cases, the SSD appropriate to the design speed in the rotary could be taken as the minimum to be provided. As a general guideline, the sight distance for the 30-40 Kmph speed should range between 30-45m.

2.14 Grades

A rotary should preferably be located on level ground. It may be more sited to lie on a plane which is inclined to horizontal at not more than 1 in 50. It is however, not desirable that a rotary be located in two planes having different inclinations to the horizontal.

A rotary may with the advantages be located on a summit. Such locations assist deceleration while approaching and acceleration while leaving the rotary. But it is essential that sufficient sight distance is available.

Rotaries in valleys always provide a full view to the approaching vehicles, but are likely to induce greater approaching speeds and have drainage difficulties.

2.15 Curbs

The curbs for channelizing and central islands should be either vertical curbs or mountable curbs. In rural sections, it is desirable that the height of the curb of the central island is not more than 225mm and a mountable type is preferable. In urban areas the curb of the central island should not be so high as to obstruct visibility.

The curbs at the outer edges of the rotary at the approach road should preferably be of the vertical type in builtup areas to discourage pedestrians from crossing over. In such areas, the approaches should be provided with curbs upto a minimum distance of 30 metre from the point where the flaring of the approach starts. To aid quick drainage, for instance at the periphery of the rotary island, a combined curb and gutter type of section will be more desirable. Curbs at the outer edges

and at approaches can be omitted in open sections of rural highways, but suitable formation indicators may be placed at the edges of the roadway.

CHAPTER 3- GEOMATICS OF THE CASE STUDY AREA

Since we have adopted the Satwari Rotary as the case study area, therefore we'll discuss about the geomatics of the case study area and then we'll compare it with IRC recommendations and conclude the results in the next chapter.

1. **From Jammu to Kunjwani:**

   Approach width: (8m+6.6m=14.6m)
   Entry Width: (9.2m+6.3m=15.5m)
   Exit width: 11.4m
   Circulation width: 14.2m

2. **From Kunjwani to Airport:**

   Approach width: (10.5m+6.5m=17m).
   Entry Width: (11.5m+6.5m=18m)
   Exit width: (10.2m+6.2m=16.4m)
   Circulation width: 11.4m

3. **From Airport to Cantonment:**

   Approach width: 9m
   Entry Width: 21m
   Exit width: 21.8m
   Circulation width: 12m

4. **From Cantonment to Jammu**

   Approach width: (14.6m+6.6m=21.2m)
   Entry Width: (9.2m+6.3m=15.5m)
   Exit width: (11.4m+6.9m=18.3m)
   Circulation width: 12.6m

Now, the rotary island is of the slightly elliptical nature, the average diameter of the island is about 26m and the diameter of the inscribed island is about 75m.

Traffic parameters:

The volume of traffic is calculated manually at the site during the peak hours at all the legs of the rotary intersection.

Volume of the traffic towards kunjwani = about 2200 (consisting of Cars, Bikes, Mini Buses, Buses & Trucks)

Volume of the traffic towards Airport= about1400-1500 (consisting of Cars, Bikes, Mini Buses, Buses & Trucks)

Volume of the traffic towards Cantonment = about 500 (lowest volume of traffic, since the movement is restricted to Army and personal vehicles only)

Volume of the traffic towards Jammu = 2300-2400 (consisting of Cars, Bikes, Mini Buses, Buses & Trucks)

The volume of traffic calculated is for peak hours.

CHAPTER 4- RECOMMENDATIONS

Comparing the details of the site area with the IRC recommendations, the following points can be concluded:

1. **Diameter reduction:** The approximate diameter of the rotary island is about 25 metres. If it is reduced at the jammu and kunjwani end, it will increase the circulation width and the width of the weaving section. Since most of the traffic prevails in that portion of the rotary island.

Conforming to Irc -65:1976, the width of the weaving section is one traffic lane (3.5m) wider than the entry width and that thing can only be achieved by redesigning the rotary island.

2. **Provision of the footpath in the surroundings:** The pedestrian traffic create conflicts many times and are major cause of road accidents. For this purpose if the footpaths are provided at the Jammu Kunjwani way, a major cause of the problem would be solved.

3. **Improvement of Traffic lighting system:** Since the administration has provided an automated traffic light system but many times they are failing to operate. Also, the ligts are provided at only some points if their numbers are increased then it would be vey helpful in streamlining the traffic and reducing the conflicts.

4. **Educating the people about the laws:** Breaking the traffic law has been a trend now a days. Example: Breaking the signals, Driving via wrong side, Parking the vehicles in a wrong place, Overtaking in a wrong way, which leads to accidents several times. Thus we recommend to the authority that they must educate the people enough so as to stop these mishappenings.

5. During the study, we have found that there are many numbers of electric poles and other pillars which are in the vicinity of roads, if they are removed and installed at some other place then it would very helpful in maintaining the traffic because most of the two wheeler traffic gets trapped in the mainstream traffic.

6. In accordance with the Irc, the minimum width of the median is 5.5 metres or 3.5 metres if the area is congested, so the width of the splitter island may be reduced to 3.5 metres because till now they are the order of 5m-5.5m.

7. **Provision of Sign boards:** The traffic related signs must be installed at the vicinity of the central island**.** And there should be awareness programmes related to these signs since most of the population is unable to understand these signs.

8. **Road Markings:** The road markings must be marked such as Zebra crossings, medians, medians describing overtaking zones and non-overtaking zones must be marked because if the people are concerned, these signs are very much helpful in streamlining the traffic.