Concept of Rotary Intersection

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Abstract— Rotary intersections or roundabouts are special form of at-grade intersections laid out for the movement of traffic in one direction around a central traffic island. Essentially all the major conflict at an intersection namely the collision between through and right-turn movements are converted into milder conflict namely merging and diverging. The vehicles entering the rotary are gently forced to move in a clockwise direction in orderly fashion. They then weave out of the rotary to the desired direction. In one sense, Rotary intersections (or Roundabouts) can be considered as a form of channelized intersection in which vehicles are guided onto a one-way roadway and required to move in a clockwise direction about a central island. At one time, the rotary intersection was considered to be the answer for all the problems associated with intersections. In fact, the rotary intersections have particular advantages and disadvantages, and the decision as to whether a rotary should be used at any individual location requires an understanding of these. Where roundabouts are properly used and designed, the efficient flow of traffic is promoted by the orderly movement of vehicles about the central island. There is only minor delay to traffic due to speed reductions and no delay, at all, due to stopping.

Key words: Rotary, Traffic Rotary

I. INTRODUCTION

Rotaries are suitable when the traffic entering from all the four approaches are relatively equal. Rotaries intersection are suitable for three or more approaches. Upper limit of traffic volume at rotary intersection is 3000 vehicle/hr and lower limit is 500 veh/hr. It is beneficial when proportion of right turning traffic is very large typically if it is more than 30 percent. Rotaries are suitable when there are more than four approaches and no separate lanes are available for right-turn traffic thus making intersection geometry complex. There are three traffic operation namely diverging, merging and weaving.

II. IRC GUIDELINES FOR SELECTING ROTARY INTERSECTION

Because of the above limitation, rotaries are not suitable for every location. There are few guidelines that help in deciding the suitability of a rotary. They are listed below

1) Lowest traffic volume for which rotary treatment should be considered is about 500 veh/hr.
2) The volumes entering from different intersection legs are almost equal.
3) The maximum volume, that a traffic rotary can efficiently handle, can be taken as 3000 veh/hr. entering from all intersection legs.
4) A rotary is advantageous at locations where the proportion of right turning traffic is high.
5) A rotary is preferable if there are other junctions so near, that there would be insufficient space for the formation of queues.

6) A rotary is very beneficial when the proportion of the right-turn traffic is very high; typically if it is more than 30 percent.
7) Rotaries are suitable when there are more than four approaches or if there is no separate lanes available for right-turn traffic. Rotaries are ideally suited if the intersection geometry is complex.

III. SHAPE OF CENTRAL ISLAND

The shape and disposition of central island depend upon various factors such the number and disposition of intersecting roads and traffic flow pattern. The conditions under which a particular shape is favored are discussed in Table 1.

<table>
<thead>
<tr>
<th>Type</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circular</td>
<td>Equal importance to all the roads meeting.</td>
</tr>
<tr>
<td>Square with round</td>
<td>Suitable for predominantly straight ahead Flows.</td>
</tr>
<tr>
<td>edges</td>
<td></td>
</tr>
<tr>
<td>Elliptical, elongated</td>
<td>To favor through traffic/to suit the geometry of the intersecting legs/to provide longer weaving lengths</td>
</tr>
<tr>
<td>oval or rectangular</td>
<td></td>
</tr>
<tr>
<td>shapes</td>
<td></td>
</tr>
<tr>
<td>Irregular</td>
<td>Shape is dictated by the existence of large number of approaches</td>
</tr>
</tbody>
</table>

Table 1: Conditions under which a particular shape

IV. ADVANTAGES AND DISADVANTAGES OF ROTARY

The key advantages of a rotary intersection are listed below:
1) Traffic flow is regulated to only one direction of movement, thus eliminating severe conflict between crossing movements.
2) All the vehicles entering the rotary are gently forced to reduce the speed and continue to move at slower speed. Thus, more of the vehicles need to be stopped.
3) Because of lower speed of negotiation and elimination of severe conflict, accidents and their severity are much less in rotaries.
4) Rotaries are self-governing and do not need practically any control by police or traffic signals.
5) They are ideally suited for moderate traffic, especially with irregular geometry, or intersections with more than three or four approaches.

There are few specific limitations for rotaries which are listed below.
1) All the vehicles are forced to slow down and negotiate the intersection. Therefore the cumulative delay will be much higher than channelized intersection.
2) Even when there is relatively low traffic, the vehicles are forced to reduce their speed.
3) Rotaries require large area of relatively at land making them costly at urban areas.
4) The vehicles do not usually stop at a rotary. They accelerate and exit the rotary at relatively high speed. Therefore, they are not suitable when there is high pedestrian movements.
V. OPERATIONS IN TRAFFIC ROTARY
As noted earlier, the traffic operations at a rotary are three; diverging, merging and weaving. All the other conflict are converted into these three less severe conflict.
1) Diverging: It is a traffic operation when the vehicles moving in one direction is separated into different streams according to their destinations.
2) Merging: Merging is the opposite of diverging. Merging is referred to as the process of joining the traffic coming from different approaches and going to a common destination into a single stream.
3) Weaving: Weaving is the combined movement of both merging and diverging movements in the same direction.

VI. DESIGN ELEMENTS
The design elements include design speed, radius at entry, exit and the central island, weaving length and width, entry and exit widths. In addition the capacity of the rotary can also be determined by using some empirical formula. A typical rotary and the important design elements are shown in figure.

VII. DESIGN SPEED
All the vehicles are required to reduce their speed at a rotary. Therefore, the design speed of a rotary will be much lower than the roads leading to it. Although it is possible to design roundabout without much speed reduction, the geometry may lead to very large size incurring huge cost of construction. The normal practice is to keep the design speed as 30 and 40 kmph for urban and rural areas respectively.

VIII. ENTRY, EXIT AND ISLAND RADIUS
The radius at the entry depends on various factors like design speed, super-elevation, and coefficient of friction. The entry to the rotary is not straight, but a small curvature is introduced. This will force the driver to reduce the speed. The speed range of about 20 kmph and 25 kmph is ideal for an urban and rural design respectively.

The exit radius should be higher than the entry radius and the radius of the rotary island so that the vehicles will discharge from the rotary at a higher rate. A general practice is to keep the exit radius as 1.5 to 2 times the entry radius. However, if pedestrian movement is higher at the exit approach, then the exit radius could be set as same as that of the entry radius.

The radius of the central island is governed by the design speed, and the radius of the entry curve. The radius of the central island, in practice, is given a slightly higher reading so that the movement of the traffic already in the rotary will have priority of movement. The radius of the central island which is about 1.3 times that of the entry curve is adequate for all practical purposes.

IX. WIDTH OF THE ROTARY
The entry width and exit width of the rotary is governed by the traffic entering and leaving the intersection and the width of the approaches road. The width of the carriageway at entry and exit will be lower than the width of the carriageway at the approaches to enable reduction of speed. IRC suggests that a two lane road of 7 m width should be kept as 7 m for urban roads and 6.5 m for rural roads. Further, a three lane road of 10,5 m is to be reduced to 7 m and 7.5 m respectively for urban and rural roads. The width of the weaving section should be higher than the width at entry and exit. Normally this will be one lane more than the average entry and exit width. Thus weaving width is given as,

\[
\text{weaving width} = \left( \frac{e_1 + e_2}{2} \right) + 3.5m
\]

Where e1 is the width of the carriageway at the entry and e2 is the carriageway width at exit.

Weaving length determines how smoothly the traffic can merge and diverge. It is decided based on many factors such as weaving width, proportion of weaving traffic to the non-weaving traffic.

X. CAPACITY
The capacity of rotary is determined by the capacity of each weaving section. Transportation road research lab (TRL) proposed the following empirical formula to find the capacity of the weaving section.

\[
Q_w = \frac{280w[1 + \frac{e}{w}][1 - \frac{e}{2}]}{1 + \frac{P}{e}}
\]

Where e is the average entry and exit width, w is the weaving width, l is the length of weaving, and P is the
proportion of weaving traffic to the non-weaving traffic. Figure shows four types of movements at a weaving section, a and d are the non-weaving traffic and b and c are the weaving traffic.

![Fig. 4: Capacity](image)

Therefore, \[ p = \frac{b + c}{a + b + c + d} \]

This capacity formula is valid only if the following conditions are satisfied.
1) Weaving width at the rotary is in between 6 and 18 meters.
2) The ratio of average width of the carriage way at entry and exit to the weaving width is in the range of 0.4 to 1.
3) The ratio of weaving width to weaving length of the roundabout is in between 0.12 and 0.4.
4) The proportion of weaving traffic to non-weaving traffic in the rotary is in the range of 0.4 and 1.

XI. CONCLUSION

Traffic rotary reduces the use of signal. It is self-governing and no vehicle stop at the rotary intersection. It also reduces the complexity of weaving traffic. Traffic rotaries reduce the congestion and provide smoother movement of traffic. Basically it is preferred for larger area. Capacity analysis of rotary is done which is having the highest proportion of weaving traffic.

REFERENCES


