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A Study of Rotary Intersection at Panipat

Surender Kadyan[1], V.K. Ahuja[2]

[1]M.Tech. student, Department of Civil Engineering, Shri Baba Mastnath Engineering College, Rohtak, Haryana, India
[2]Profeesor, Department of Civil Engineering, Shri Baba Mastnath Engineering College, Rohtak, Haryana, India

ABSTRACT

Increasing trends of traffic in urban area is a major concern in all the cities in India. The heterogeneous traffic are more diverse in nature due to lane changing and lack of lane discipline characteristics of driver's in India. Rotary intersections or round abouts 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 conflicts at an intersection namely the collision between through and right-turn movements are converted into milder conflicts 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. The rotary intersections are of the most vital components of urban roadway network. Intersection is one when either three or more road meets or intersects each other. It has been observed that the entry capacity of vehicles become comparatively lower at intersection than that of the straight portion of the road due to reduction in speed. Hence, long queues on intersections often observed, causing huge fuel consumption as well as environmental pollution in the urban area beside considerable time loss. The situation become more intense during the peak hours when increase of traffic volume by 50% than normal traffic. The traffic flow characteristics at rotary intersections are studied to observe the performance of intersection. The capacity of the roadway rotary depends on the flow at different legs approaching the rotary. The present traffic scenario is usually used to characterize the present traffic condition to access the different parameters at different types of intersection.

INTRODUCTION

Mixed type of traffic prevails in the Indian roadways particularly in the urban areas. In mixed traffic condition the road width is shared by all types of vehicles such as light motorized vehicles, heavy motorized vehicles and non-motorized vehicles. The rapid urbanization with economic growth results in large volume of traffic during the peak hours in most of the Indian cities. Large traffic volume is the prime cause of traffic congestion at urban road network mainly at the intersections. Traffic congestion in urban area is a serious problem and is increasing day by day with the increase in population/ vehicular ownership due to uprising economic status of urbanities. The traffic congestion not only raises the vehicle operating cost, travel time of trip makers but also is the prime reason of poor performance at the intersection. The performance of intersections is a key issue to address the congestion problem. To carry out the study Panipat city has been selected as a case study area.

There are mainly three types of intersection - controlled intersection, uncontrolled intersection and Rotary intersection. In this study we deal with rotary intersection. Data collected on rotary intersection need to be extracted to determine peak hour for the intersection, entry volume at intersection.

OBJECTIVE

The objectives of the study are to Rotary intersections are studied based on weaving traffic and entry volume. These parameters are function of traffic volume and geometric features. These parameters are critically observed in respect of distance from CBD boundary. Relative performance is compared with respect different rotary location. The distances of each of the rotaries are important with respect to CBD boundary. Hence the distances of rotaries are required measured directly, so as the traffic operational area of these rotaries.

LITERATURE REVIEW

Rotary intersections or round abouts 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 conflicts at an intersection namely the collision between through and right-turn movements are converted into milder conflicts namely merging and diverging.

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 conicts 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, none of the vehicles need to be stopped, unlike in a signalized intersection.
3. Because of lower speed of negotiation and elimination of severe conflicts, 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.

Although rotaries over some distinct advantages, 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.

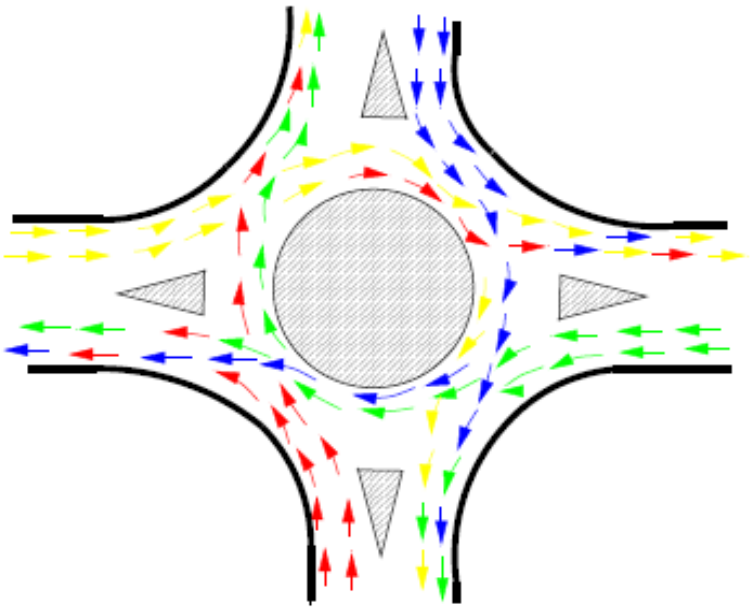

Fig. 1 Traffic operations in a rotary

Guidelines for the selection of rotaries

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. Rotaries are suitable when the traffic entering from all the four approaches are relatively equal.
2. A total volume of about 3000 vehicles per hour can be considered as the upper limiting case and a volume of 500 vehicles per hour is the lower limit.
3. A rotary is very beneficial when the proportion of the right-turn traffic is very high; typically if it is more than 30 percent.
4. 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

Traffic operations in a rotary

As noted earlier, the traffic operations at a rotary are three; diverging, merging and weaving. All the other conflicts are converted into these three less severe conflicts.

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.

These movements are shown in figure. It can be observed that movements from each direction split into three; left, straight, and right turn.

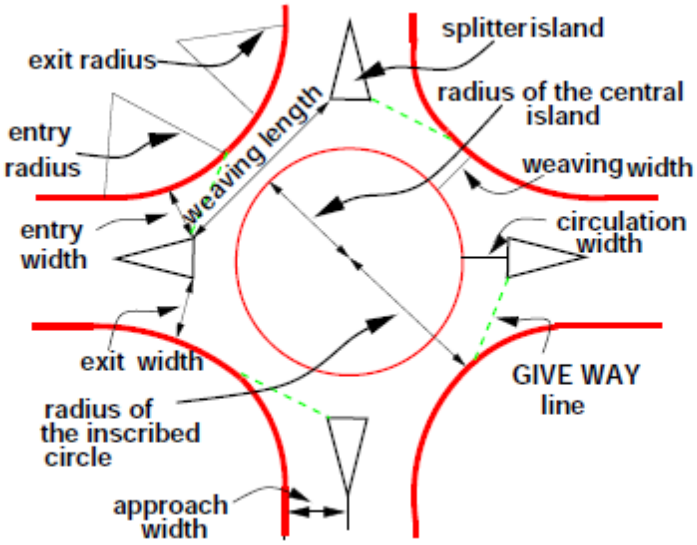

Fig. 2 Design of a rotary

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.

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.

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 entry radius of about 20 and 25 metres 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 radius so that the movement of the traffic
already in the rotary will have priority. The radius of the central island which is about 1.3 times that of the entry curve is adequate for all practical purposes.

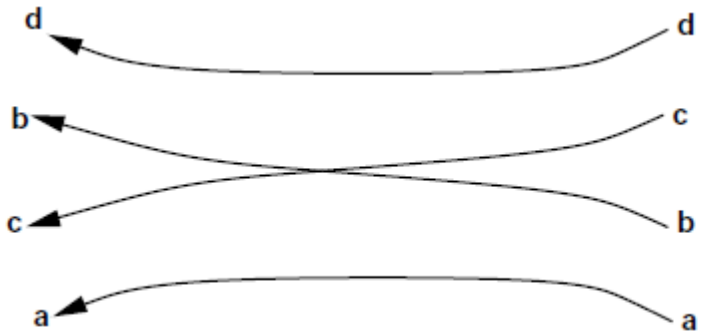

Fig. 3 Weaving operation in a rotary

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 approaching 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,

$$\mathrm{W_{weaving}} = \left(\frac{\mathrm{e_1} + \mathrm{e_2}}{2}\right) + 3.5\mathrm{m}$$

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 etc. This can be best achieved by making the ratio of weaving length to the weaving width very high. A ratio of 4 is the minimum value suggested by IRC. Very large weaving length is also dangerous, as it may encourage over-speeding.

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 _nd the capacity of the weaving section.

$$Q_w = \frac{280w[1 + \frac{e}{w}][1 - \frac{p}{3}]}{1 + \frac{w}{l}}$$

where e is the average entry and exit width, i.e, (e1+e2)/2 , 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. 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 metres.
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.
5. The weaving length available at the intersection is in between 18 and 90 m.

CONCLUSION

Traffic rotaries reduce the complexity of crossing Traffic by forcing them into weaving operations. The shape and size of the rotary are determined by the Traffic volume and share of turning movements. Capacity assessment of a rotary is done by analyzing the section having the greatest proportion of weaving Traffic.

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