

# Comprehensive Review on Capacity Analysis of Rotary Intersection

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**Abstract:** *Rotary intersection, which is a special type of at-grade intersection, where all converging vehicles are forced to move round a central island in clock-wise direction. 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. 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. The traffic flow characteristics at rotary intersections are study 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. The crossing of vehicles is avoided by allowing all vehicles to merge into the streams around the rotary and then to diverge out to the desired radiating road. Thus the crossing conflict is eliminated and converted into weaving maneuver or a merging operation from the right and diverging operation to the left. In this paper, an comprehensive review is presented on capacity analysis of rotary intersection.*

**Keywords:** Rotary intersection, mixed traffic condition, Capacity

## I. INTRODUCTION

A rotary intersection is a specialized form of intersection-at-grade in which the traffic moves in one direction round a central island. Rotaries are appropriate for many intersections including locations experiencing high number of crashes, long traffic delays, and approaches with relatively balanced traffic flows. In order to avoid the conflict between entry vehicles and circulating vehicles, there are a mass of confluence operations at rotary weaving sections. The performance parameters are difficult to be determined due to the great complexity of traffic performances at rotary weaving areas. For the safe movement of the vehicles, it is essential to understand the operational performance of the roundabout. Capacity is one such parameter which explains the operational performance, traffic scenario, and level of service. In contrast to traffic flow condition in developed countries, Indian traffic condition is totally different.

Intersections are a key feature of road design in four respects:

1. Focus of activity: The land near intersections often contains a concentration of travel destinations.
2. Conflicting movements: Pedestrian crossings and motor vehicle and bicycle turning and crossing movements concentrated at intersections.
3. Traffic control, At intersections, movement of users is assigned, through traffic control devices such as yield signs, stop signs, and traffic signals. Traffic control often results in delay to users travelling along the intersecting roadways
4. Capacity, In many cases, traffic control at intersections limits the capacity of the intersecting roadways, defined as number of users that can be accommodated within a given time period

### 1.1 Guidelines for the Selection of Rotaries

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.

### 1.2 Traffic Operations in a Rotary

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.

Design of a safe intersection depends on many factors. The major factors can be classified as under: (1) Human Factors (2) Traffic Considerations (3) Road and Environmental Conditions. If maximum volume of traffic is  $\leq 3000$  Vehicles/hour rotary can handle efficiently, entering from all intersection legs.

Rotaries are advantageous in locations where the proportion of right turning traffic at a junction is high.

- When traffic volume is less than capacity the solution to manage the traffic is to design signals for intersection, if it's vice versa.
- Traffic engineers should think of 3 dimensional solutions which are grade-separate intersection design, it will handle traffic up to 10000PCU/hr.
- Additional to the conventional solution there are unconventional solution to reduce the potential conflict point and minimize the congestion at intersection unconventional intersections

## II. LITERATURE REVIEW

Sitesh Kumar Singh, Karan Prabhakar [1] presented in his study that the work on roundabout models mostly concentrates on determining the capacity of an approach based on the entering and circulating flows. Approach capacity is calculated as a mathematical function of critical headway and follow-up headway. Critical headway at roundabouts represents the minimum time interval in circulating flow when an entering vehicle can safely enter the roundabout. Roundabouts have fewer conflict points than traditional intersections. Also require lower operating speeds for both the driver entering the roundabout and the driver driving in the roundabout.

Veethika Gomasta, Mohit Malviya, Abhishek Singh, Salim Akhtar [2] gives an idea that signalised intersection are critical element of an urban road transportation system and maintaining this control system at their optimal performance for different demand condition has been primary concern of the traffic engineer. Round about is a five legged intersection situated near DB city mall, MP Nagar, Bhopal. In which study traffic volume is done by manual method. In their work, they have gathered the data by calculating the traffic volume at four phases of intersection. Survey is done throughout the day at 2 hour interval -10 am to 12 pm, 1pm to 3pm, and 5pm to 7pm. Thus survey is carried out in a consecutive day in a week. Classified traffic volume data are collected for 12 min duration. The classified traffic volume is converted to a common unit called passenger car unit.

Sandeep B. Rajurkar, Mithil S. Soni, Mohan M. Dusane, Kunal A. Mahale, Amar S. Gorule [3] gives an idea about traffic congestion which is a major problem at an intersection in urban areas. The location of survey area is at charkop market square kandivali west. In this study traffic survey is done by manual method. Three observers were appointed at

each leg. They carried out six surveys at peak hour on working three days at morning and evening. They got maximum traffic volume at morning peak hour and selected that volume for a design of rotary. After that they calculated weaving length, entry, exit radius. They decided to construct rotary in Charkop market, since the result will full fill the IRC 65 requirement.

Ramu Arroju, Hari Krishna Gaddam, Lakshmi Devi Vanumu & K. Ramachandra Rao. [4] studied Roundabout, which are located in Chanakyapuri area of New Delhi. It is Satya Marg-Vinay Marg roundabout. The roundabout legs north bound (NB), east bound (EB), south bound (SB), and west bound (WB) are numbered as legs 1, 2, 3, and 4 in clockwise direction and similar nomenclature is used throughout the paper. Manual method of vehicle count is adopted as the turning movements of all vehicles are difficult to extract from a video. In total, 13 trained enumerators were used for this purpose of which 4 persons are assigned to count entry flows at 4 legs, 4 persons for exit flows at 4 legs, and 4 more persons are asked to count the left turning vehicles. In addition, one more person counted the vehicles in the weaving section between legs 1 and 2. As per the Indian Roads Congress Method (IRC 65-1976).Has concluded traffic increasing and growth are the huge concern in all urban cities of India.

Debasish Das, Prof.Mokaddesh Ali Ahmed, Saikat Deb [5] gives an idea about increasing trends of traffic in urban area which is a major concern in all cities in India. The heterogeneous traffic are more diverge in nature due to lane changing and lack of lane discipline characteristics of drivers in India. The situation becomes more intense during the peak hour when increase of traffic volume by 50% than normal traffic. The traffic flow characteristics at rotary intersection were studied to observe the performance of intersection. In this study Silchar city has been selected as a case study area. Ambikapatti is considered for evaluation of performance. Ambikapatti is one of the major uncontrolled intersections in Silchar city. The performance of this intersection is investigated based on critical gap acceptance criteria.The data were recorded for each 15 min/ hr of our survey duration i.e. from 9:30 hours to 19:30 hours on a typical week day. They recorded the number of arrival and departure of different type of class of vehicles. for both off-peak and peak hour the cumulative arrival rate and cumulative departure rate has been recorded.

Akshat Upadhyay, Bharat Tyagi & Vaishna Bansal. [6] under taken study on capacity analysis Golf course rotary intersection. The capacity studies on the rotary are done from all four directions and which is calculated based on the established norms of Indian road congress (IRC:65, 1976). The performance analyses of rotaries are based on various parameters such as total entry & exit traffic volume, weaving lengths & width. The resulting performance leads to a new modal development and its validation based on calculated traffic volume density by collected data of traffic volume at the particular location. There are two methods of traffic volume measurement -1.Manual method 2.Automaticmethod.Considering the cost factor and available facilities they used manual method for calculating traffic volume count.Readings were taken at entry and exit points to the roads going in all four directions using tally method of counting for which a measuring tape was used to measure dimensions like radius of rotary, entry and exit width, weaving width, weaving length etc. Capacity of rotary is determined by the capacity of each weaving section. The various components are thus calculated

Rakesh kumar Chhalotre , Dr. Y. P. Joshi [7] studied counted traffic volume on that square manually for 7 days and peak hour traffic data was obtained. They found out capacity of rotary and suggested the design parameters. The capacity obtained from traffic volume study exceeded the practical capacity of rotary. Hence provision for signalized intersection was given to reduce the volume at intersection within specified limit.

S. Vasantha kumar et al. [8] conducted a video graphic survey for eight hours during the day to determine the traffic volume at the intersection and the capacity of the intersection. The rotary's practical capacity was found to be 3020 pcu, which was significantly higher than the reported traffic flow of 2665 pcu.

Sonalika Maurya, Mr. Ajeet Singh [9] collected traffic volume at the study intersection by manual method and counted it. They found that, the capacity of roundabout was exceeded due to present traffic volume so they suggested signalized intersection to control the traffic coming at roundabout.

Parth M. Pande, Srinath Karli [10] evaluated the capacity of the rotary was determined. The current traffic flow at a signalized intersection was greater than the intersection's capacity. As proposed and design parameters were supplied for the reduction of delay and increase in capacity of intersection rotary.

Shrirame V. B. and Nagoshe S. R.et. al., [11] describes that Rotaries are suitable when the traffic entering from three or more approaches are relatively equal. 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. Rotaries are suitable when there are more approaches and no separate lanes are available for right-turn traffic thus making intersection geometry complex. His paper work also explains about that the traffic operations at a rotary are three; diverging, merging and weaving. All the other conflicts are converted into these three less severe conflicts.

Ishanya P, Shriram Marathe, Y R Suresh [12] classified traffic volume count was performed at Nanthur intersection in the peak hours (7:30 – 10:00 AM, 12:30 – 2:30 PM & 4:30 – 8:00 PM). The survey was done by video photography method which gives permanent record of volume count. The same empirical formula is used to calculate traffic volume at weaving section which is proposed by Transportation road research lab (TRL). On the basis of their study they concluded that, the rotary intersection at Nanthur junction is not functioning adequately due to a reduced capacity and abrupt growth of traffic in scenario. The attempt made to design signal was failed therefore it is essential to redesign the rotary intersection.

Siteshkumar singh, Karan Prabhakar [13] examined traffic volume on existing roundabouts and gathered data on the roundabout's geometric features and operational status. They discovered that the capacity of the existing roundabout had reached its limit. They made recommendations for geometric features to boost the capacity of the roundabout based on the results of the rotary junction study and improvement.

Tom V. Mathew et al, [14] published a paper on traffic rotaries in which they provided all the theoretical knowledge about rotaries includes guidelines for selection of rotaries, traffic operation in rotaries, design elements , capacity of rotary.

Shrirame and Nagoshe [15] describes that traffic rotary at road intersection is special form of grade change of lanes to channelize movement of vehicles in the one direction around a central island. With rapid growth of traffic it was experienced by than widening of roads and providing flyovers have become imperative to overcome major conflicts at intersections. In this way, major conflicts are converted into milder conflicts like merging and diverging. The vehicles entering the rotary are gently forced to move in a clockwise direction. They then weave out of the rotary to the desired direction.

Shaikh Vasim Abdulsalim , Khushbu Bhatt and Siddharth Gupte [16] describes that increasing trends of traffic density 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 drivers in India. The rotary intersection is of the most vital components of urban roadway network. Intersection is one when either three or more road meets or intersects each other Dayananda H S, Manoj P, Ram Kumar P, Gagana D [17] suggested redesigned parameter for rotary. They measured traffic volume over seven days using a video camera mounted on a building near the intersection. They calculated the capacity of the rotary by adjusting dimension with the same weaving ration as the previous capacity after calculating all traffic volume data.

Gaurav D. Hingwe , Miss. K. P. Nichat [18] discussed design Elements of Roundabout and Procedure to design this Elements in systematic manner as per IRC Guideline has been studied. Traffic Roundabout at any complex intersections is the special traffic Regulatory arrangement constructed for safe and easy movement of vehicles around the large central Island.

Ankit Pandey, Vaibhav Dubey [19] designing rotaries at intersections is discussed and a software package is developed for use in road works. In this project we have carefully analyzed and designed the TATMILL CHAURAHA intersections. Therefore, that traffic flows efficiently and there will be no traffic jams or accidents

Ayush Verma, Deerendra Varshney [20] evaluated capacity of traffic rotary is 3104 PCU per hour in east south direction at Gol Chakkar Kirti Stambh Rotary Intersection as per present traffic condition which is almost under satisfied condition for urban rotary intersection

Many studies have shown that roundabouts increase the efficiency of intersections in the following ways:

- Reduced delays
- Lower operating costs
- Reduced environmental impact

### III. CONCLUSION

After comprehensive review of literature, it is observed that the most of the studies have undertaken at four leg rotary intersections, so the study on six leg intersection is proposed in view of study the capacity analysis of rotary intersection. It is proposed to conduct study of capacity analysis of rotary intersection for an uncontrolled six leg intersection ( Medical Square) located in Nagpur India. The intersection has six approach roads with two-way traffic in all the approach roads and there is no signal or traffic police to control the traffic at present and hence experiences traffic chaos during peak hours. The capacity study for intersection will be calculated based on the established norms of Indian road congress ( IRC: 65, 1976 ).Rotary intersections are studied based on weaving traffic and entry volume. These parameters are function of traffic volume and geometric features. The performance analysis of rotaries are based on various parameters such as total entry traffic volume, weaving traffic, capacity of weaving section and distances from CBD boundary

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