

**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH
TECHNOLOGY****STATISTICAL ANALYSIS OF TRAFFIC OF ROTARY INTERSECTION****Sitesh Kumar Singh*, Karan Parbhakar*** Department of Civil Engineering, Assistant Professor, Career Point University, Kota, Rajasthan,
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ABSTRACT

In this today's world, every person is willing to have their own vehicle. Their willingness led to the gradual growth in the number of vehicles. As per the considerations for the movement of the vehicles, lots of roadways have been constructed with several reinforcement parameters. The place where two or more road network meets, there is a construction of different types of intersections, rotaries/roundabouts. Rotary junction has efficiency to manage the various traffic congestion. Evaluation of rotary junction capacity is very important. As the evaluation of rotary junction is directly related with several traffic and motorist's parameters such as level of service, travel time, delays, accidents, operation costs, environmental factors, etc.

So, there should be proper attention for the evaluation and improvements in the rotary junctions. As at the rotary junction, lots of traffic are diverted to different routes as per the travel of motorists. There should be decrease in the congestion, accidents, etc. So, there must be improvement parameters to be followed for the improvement of rotary junctions. Improvement of rotary junction justification have been considering by evaluation of the rotary junction of Dogra Chowk, Jammu.

Traffic volume study is the major study for the evaluation of the traffic condition of the rotary junction. To analyse the traffic volume, traffic survey has been considering in the peak hours on the rotary junction.

KEYWORDS: Traffic Survey, Rotary junction, roundabouts, Traffic congestion, Traffic volume.**INTRODUCTION**

A roundabout is an alternative form of intersection for traffic control. Roundabouts are circular in shape generally and they are characterized by yield on entry and circulation around a central island. Roundabouts are appropriate for many intersections including locations experiencing high number of crashes, long traffic delays, and approaches with relatively balanced traffic flows. Roundabouts have the potential to resolve various traffic flow problems. Traffic volume on one approach is significantly higher that it prevents vehicles at any other approach from entering the roundabout especially at a downstream approach or the next following approach. Evaluation of junction capacity of roundabout is very important since it is directly related to delay, level of service, accident, operation cost, and environmental issues. There are three legs, four legs, five legs and six legs roundabouts in Jammu and most of them have served more than 13 years. Since, little attention has been paid to the design and capacity evaluation of the roundabouts, no one knows their capacities or level of services.

Current research 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. This method is not sensitive to roundabout geometric parameters such as inscribed circle diameter, entry angle, etc. In addition, the level of traffic stream performance itself can influence driver behaviour and increasing the complexity of modelling roundabout operations.

Critical headway and follow-up headway are two important parameters to perform operational analyses of roundabout. Critical headway at roundabouts represents the minimum time interval in circulating flow when an

entering vehicle can safely enter the roundabout. A driver would enter the roundabout when faced with any headway equal to or greater than the critical headway.

Several roundabout capacity models exist and can be classified into two broad categories - theoretical and empirical. The Highway Capacity Manual (HCM 2010) roundabout tanner capacity model is an analytical (exponential regression) model with clear basis in gap-acceptance theory. The NCHRP Report 572 model is based on empirical exponential regression) capacity model with no explicitly.

Roundabouts have fewer conflict points than traditional intersections as shown in Fig.1. and also require lower operating speeds for both the driver entering the roundabout and the driver driving in the roundabout.

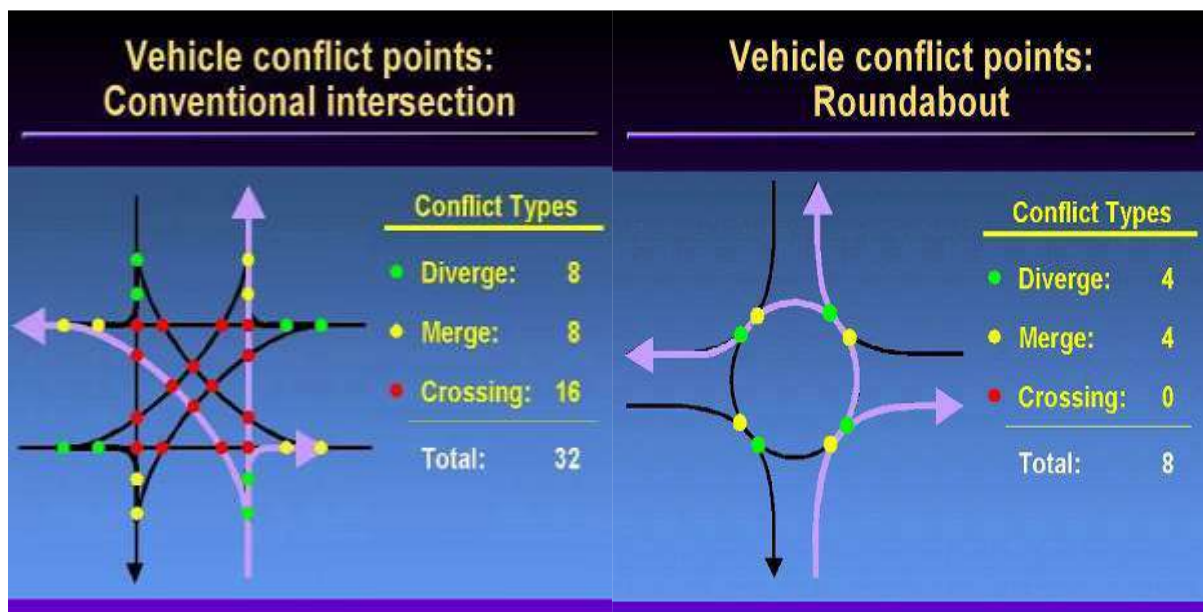


Fig.1. Vehicle Conflict Point Comparison

PROBLEM STATEMENT

Now days it is common to see traffic congestion at intersections of roundabouts in Dogra Chowk, Jammu at peak hours in the morning and evening. Hence the traffic police need to intervene in the situation to regulate the traffic flow. Otherwise, it would be practically difficult to have normal traffic flows, particularly at roundabout junctions, which is more dependent on driver behaviour and balanced traffic flow between the approaches. This problem will continue and it may more difficult in the future due to the rapid growth of population and vehicle numbers in Jammu. Poor road planning and sub-standard geometric conditions of roundabouts have a significant effect on roundabout capacity and traffic congestion.

Therefore, it is necessary to evaluate the capacity of roundabouts for proper traffic operation.

OBJECTIVES

The specific objectives of this research are:

1. To compile available information regarding capacity analysis of roundabouts through literature review.
2. To select the appropriate methodology to evaluating the capacity of roundabouts in Indian context.
3. To define and generate the capacity of roundabout junctions.
4. To decrease the traffic delays and accidents.
5. To analyse the necessary design improvements of rotary junction.
6. To propose the further development or extension if needed for the rotary present.

APPROACH AND METHODOLOGY

There are lots of parameters to be consider in order to carry out the research in the field of improvement in rotary junctions. So, the set of parameters and methodologies of this research is expressed in the form of flowchart as shown in Fig.2.



Fig.2. Approach and Methodology

DATA COLLECTION

Data collection is the major effort for the execution of research. For the research of improvement of rotary junction, there are lots of study to be carried out and can be justified by data collection. As for example, to analyse the traffic volume, traffic survey need to be carried out, to analyses the traffic safety parameters, traffic accident data need to be obtained, etc. Data collection methods to be adopted as discussed represented in methodology. The tally sheet has been used to record the traffic survey data of the different routes as shown in Fig.3.

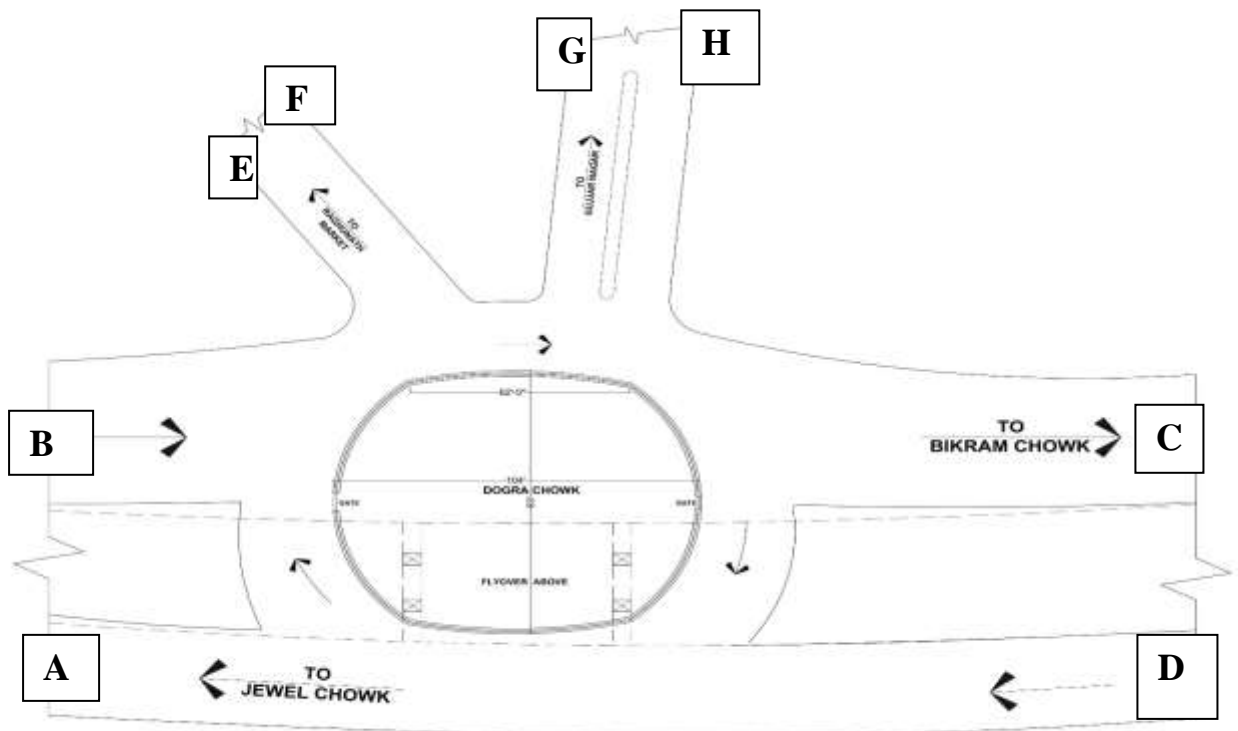


Fig.3. Layout of Rotary Junction in Jammu

On Dogra Chowk, Jammu, there is a very big Rotary Junction and over which there is a flyover constructed. The rotary comprise of total four roads of two lanes each. For the ease of route identification, there is an alphabetic notations of the different route.

Towards Jewal Chowk (Left) – A, Towards Jewal Chowk (Right) – B, Towards Bikram Chowk (Left) – C, Towards Bikram Chowk (Right) – D, Towards Raghunath Market (Left) – E, Towards Raghunath Market (Right) – F, Towards Gujjar Nagar (Left) – G, Towards Gujjar Nagar (Right) – H

So, from these different roads, following route networks/legs were analysed:

D – A, D – E, D – G, D – C, B – C, B – E, B – G, B – A, F – G, F – C, F – A, F – E, H – C, H – A, H – E, H – G. For all the above stated leg, traffic survey has been conducted individually for the peak hour in morning and evening as shown in Table.1. for traffic survey of route B – A. Fig.4. showing Time v/s Traffic Volume. As same, all the routes were surveyed.

Table.1. Traffic Survey data of Route B - A

Time	2 Wheeler	3 Wheeler	Mata dor Van	Car	Jeep/ Van	Mini Bus	Bus	LCV	Truck	Bicycle	Total	PCU
PCU	0.75	1	1	1	1	1.4	2.8	1.4	2.2	0.5		
09:00-09:30 am	211	34	34	112	21	21	8	8	1	45	495	446.95
09:30-10:00 am	210	35	34	113	21	22	7	9	0	44	495	445.5
10:00-10:30 am	222	31	32	113	22	21	7	10	0	45	503	450
10:30-11:00 am	202	33	33	112	23	21	8	11	0	55	498	447.2
11:00-11:30 am	198	33	23	113	21	19	6	12	0	45	470	421.2
11:30-12:00 pm	198	31	22	114	23	18	7	9	0	43	465	417.4
04:00-04:30 pm	199	32	22	113	22	16	9	9	0	44	466	420.45
04:30-05:00 pm	243	34	33	114	21	19	8	9	0	54	535	472.85
05:00-05:30 pm	202	33	32	113	23	20	7	8	0	43	481	432.8
05:30-06:00 pm	198	31	33	112	22	21	6	7	0	42	472	423.5
06:00-06:30 pm	188	32	34	112	21	22	7	8	0	44	468	423.6
06:30-07:00 pm	198	32	34	112	22	21	8	7	1	45	480	434.8

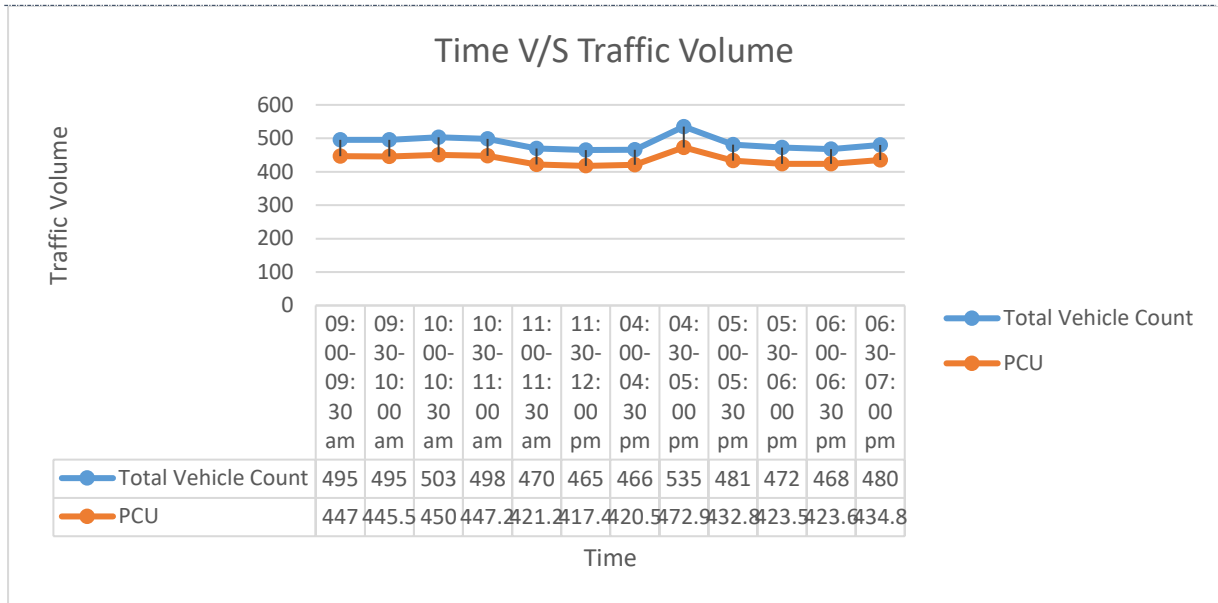


Fig.4. Time v/s Traffic Volume for Route B – A

DATA ANALYSIS

Data analysis deals with the analysis of the data collected during traffic survey with to come with a result. To study about the improvement features and design of a roundabouts, it is necessary to analyse the very first traffic volume. The mathematical calculations have to be carried out to analyse the data and the analysis must be presented on the graph to study it is more good manner.

ROTARY TRAFFIC VOLUME ASSIGNMENT

The individual traffic volume in terms of PCU have been analysed from all the individual leg of the rotary as shown in Fig.5, Fig.6, Fig.7 and Fig.8.

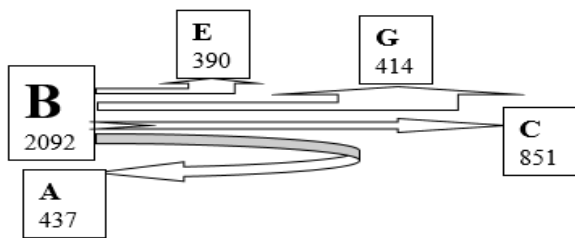


Fig.5. Traffic Volume Distributed from B

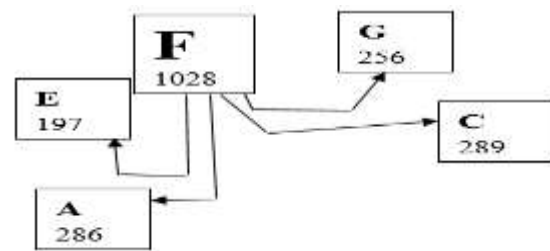


Fig.6. Traffic Volume Distributed from F

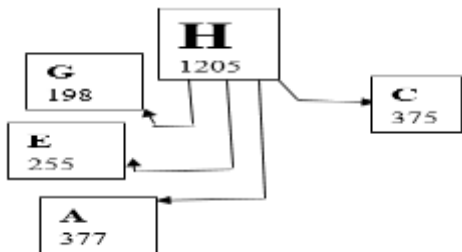


Fig.7. Traffic Volume Distributed from H

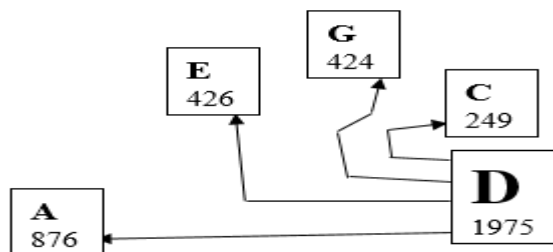


Fig.8. Traffic Volume Distributed from D

The traffic volume calculated in peak hour is assigned to the different leg as shown in Fig.9.

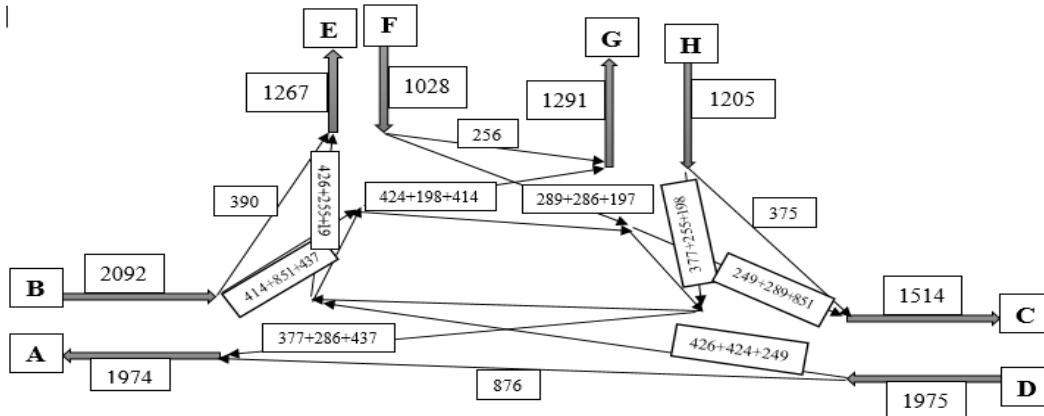


Fig.9. Traffic Network Assignment

The following 2 – way traffic flow have been observed.

- A-B leg: 4066 PCU/hr.
- C-D leg: 3489 PCU/hr.
- E-F leg: 2295 PCU/hr.
- G-H leg: 2496 PCU/hr.

As per Highway Capacity Manual (1965), Highway Research Special Report, 87, Washington,1965, a 4-lane road with moderate interference from cross traffic has capacity of 1400- 1800 PCU/hr. in one direction and of 2-lane road with moderate interference from cross traffic has capacity of 700 – 900 PCU/hr. in one direction.

Analysis of leg A-B:

Leg A have traffic 1974 PCU/hr. > 1400 – 1800 PCU/hr., Leg B have traffic 2092 PCU/hr. > 1400 – 1800 PCU/hr. Analysis of leg C-D:

Leg C have traffic 1514 PCU/hr. which lie between 1400 – 1800 PCU/hr., Leg D have traffic 1975 PCU/hr. > 1400 – 1800 PCU/hr.

Analysis of leg E-F:

Leg E have traffic 1267 PCU/hr. > 700 – 900 PCU/hr., Leg F have traffic 1028 PCU/hr. > 700 - 900 PCU/hr. Analysis of leg G-H:

Leg G have traffic 1291 PCU/hr. > 700 – 900 PCU/hr., Leg H have traffic 1205 PCU/hr. > 700 - 900 PCU/hr. The leg which is exceeding the traffic volume capacity limit has been circled in red colour as shown in Fig.10.

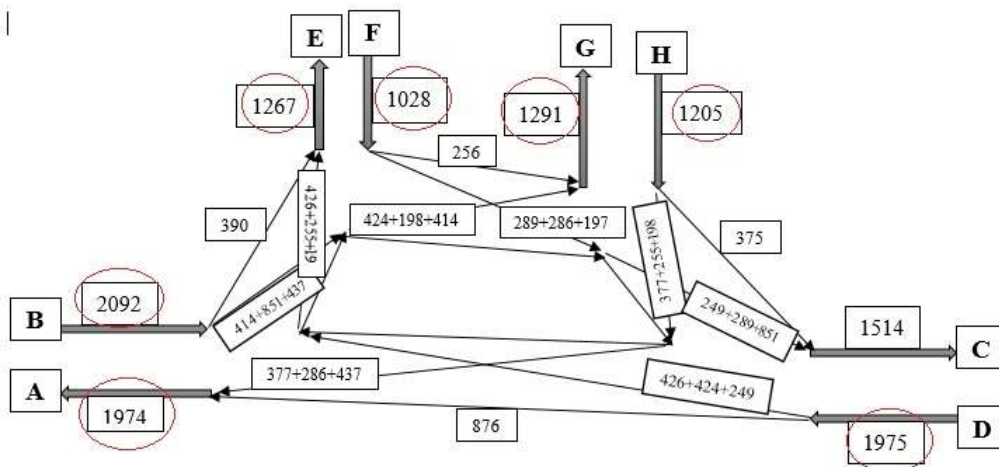


Fig.10. Traffic exceeding their leg capacity

ROTARY TRAFFIC VOLUME CAPACITY

The capacity of the rotary is directly determined by the capacity of each weaving section. The capacity of weaving section is determined by the geometric layout, including entrance and exits, and the percentage of weaving traffic. The transport and road research laboratory (U.K.) which has pioneered research on this aspect, recommends the following formula which is a modification of well-known Wardrop formula:

$$Q_p = \frac{280w \left(1 + \frac{e}{w}\right) \left(1 - \frac{P}{3}\right)}{1 + \frac{l}{w}}$$

Where, Q_p = Practical capacity of the weaving section of the rotary in PCU/hr.

w = width of weaving section in meters.

e = average entry width of the rotary in meters.

l = Length of weaving section between the ends of the channelizing island in meters.

P = proportion of weaving traffic. i.e., ratio of the sum of crossing streams to the total traffic on the weaving section.

$$P = \frac{b+c}{a+b+c+d}$$

The width of carriageway at entry and exit is 10.0 m, the width of non-weaving section is also 10.0 m.

So, width of weaving section, $e = ((10+10)/2) + 3.5 = 13.5$ m.

The minimum length of the weaving section should be 30 m but it fails the requirement that the ratio l/w should be at least 4.

So, adopt 55 m, which gives a l/w ratio slight greater than 4.

There is weaving in each section but the maximum weaving occurs in the F – A section.

$$\text{So, } P = \frac{(289+286+197)+(377+286+437)}{1872+(249+289+851)} = 0.57$$

$$Q_p = \frac{280 \times 13.5 \left(1 + \frac{10}{13.5}\right) \left(1 - \frac{0.57}{3}\right)}{1 + \frac{55}{13.5}}$$

$$= 4280 \text{ PCUs/Hour.}$$

This is very much higher than the traffic flow of 2746 PCU/hour.

RESULTS

While the study of rotary junction or roundabout present at Dogra Chowk, Jammu, lots of parameters were monitored, evaluated and analysed to understand the traffic improvement necessities to be implemented or adopted. Traffic volume is the major element for the analysis of the traffic capacity. In this study, traffic volumes were analysed from each of the leg of the rotary junction. The volume and capacity were considered in terms of Passenger Car Unit (PCU) for the uniformity of the analysis.

After the study of the traffic capacity and volume features of the rotary junction at Dogra Chowk, Jammu, following results were observed:

- a. Rotary entrance leg was identified as B, F, H & D.
- b. Rotary exit leg was identified as A, E, G & C.
- c. In entrance leg, the leg route exceeding the traffic volume were identified as B (2092 PCU/hr.), F (1028 PCU/hr.), H (1205 PCU/hr.) and D (1975 PCU/hr.).
- d. In exit leg, the leg route exceeding the traffic volume were identified as A (1974 PCU/hr.), E (1267 PCU/hr.) and G (1291 PCU/hr.).
- e. The exit leg, not exceeding the traffic volume was identified as C (1514 PCU/hr.).
- f. The weaving sections were identified with the maximum weaving among all the weaving routes as F – A route.
- g. The traffic volume study analysis gives the result need for the improvement in the rotary capacity to approximately all the routes.
- h. To cope with the improvement in rotary capacity, there should be improvement in the design features of the rotary junction.
- i. Until the rotary design elements not be improves, the design speed should be regulating to reduce the congestions and accidents.

CONCLUSION

In roundabout or rotary design, guidance based on principles is of greater value than a set of rules. The engineer needs design methods based on fundamental relationships between geometry, capacity and safety that will enable him/her to get directly from proposed geometry to realistic estimates of operating conditions. The result of this

study gives practicing and studying empirically based roundabout design is that operating problems stem from the following:

- A poor understanding of the way site context influences the design;
- Designers don't always recognize the operating effects of their geometric design choices;
- Overall composition is often overlooked in the pursuit of details.

Overall, it has been concluded that, rotary or roundabout evaluation is need periodically. It analyse the need of the improvements for the better movement of vehicles and safety of motorists and pedestrians.

RECOMMENDATIONS

On the basics of the result obtained for the study of rotary junction and its improvement, following recommendations have been suggested:

- a. There should be improvement in radius at entry, radius at exit, radius of central island, weaving lengths, width of carriageway at entry and exit, width of rotary carriageway, entry and exit angles, external curb lines, super-elevation and camber, etc.
- b. Drainage system should be improved for the better movement of vehicles and pedestrians in the rainy season.
- c. Proper installation of street light should be preferred with 24-hour power supply for proper visibility.
- d. The extra length provided around the rotary should be used for the extension of lanes if possible.
- e. Heavy Commercial Vehicles should must have entry limit. i.e. time limit for entry.
- f. Overpass made above the rotary junction should be used in case of heavy traffic at rotary.
- g. To reduce the traffic on the rotary junction, the small vehicles such as 2 wheelers, 3 wheelers going to route E and G should be diverted through a shortest direct path without using rotary.
- h. Leg A should be widened so that it can cater the more exit vehicles.
- i. Leg C should be widened so that it can cater the more exit vehicles.
- j. Heavy vehicles such as Trucks entry should be 9 PM to 8 AM.
- k. Vehicles moving from D to A and B to C, small vehicles must use overpass.

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