



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 7, July 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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Design of a Modern Round about for a 4- Leg Intersection in Jalgaon

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ABSTRACT: A technique to manage traffic at congested crossings is to build a roundabout or rotary intersection, a special kind of at-grade intersection where all convergent vehicles must drive around a center island in a clockwise direction. The goal of the current study is to create a rotary for a 4-leg crossroads in Jalgaon at Chatrapati Shri Shivaji Maharaj Chowk. The intersection contains four approach roads, all of which have two-way traffic. Since there is currently a signal or traffic police to regulate the traffic, there is mayhem at peak hours. To collect data, manual counting was conducted from the veranda of an apartment building located near the intersection for eight hours, from 9:30 am to 1:30 pm and from 4:00 pm to 8:00 pm on a typical working day. Every 15 minutes, the traffic volume for all five classes of vehicles was extracted and converted to passenger car units (PCU). The analysis of traffic data showed that during peak hours from 5:45 pm to 6:45 pm, the proportion of weaving traffic, i.e., the ratio of the sum of crossing streams to the total traffic on the weaving section, was found to be 0.78. The proportion of the weaving width to the weaving length of the roundabout is within the prescribed range of 0.4 to 1, as determined by this study. The practical capacity of the roundabout is 2900 PCU, based on the calculated values of the average entry width and the weaving section. The capacity of the roundabout should not exceed 3000 PCU for effective traffic movement. Therefore, the roundabout can handle the current traffic volume effectively.

KEYWORDS: Roundabout, intersection, vehicle, traffic, crossing, design, rotary.

I. INTRODUCTION

Traffic congestion is a major problem in India's major cities. It is caused by the exponential growth of personal vehicles, as well as an increase in journey lengths. In Jalgaon district, there are about 258,995 registered vehicles, and the number of registered vehicles is growing by 7% each year. According to traffic count data, the city's roadways had a total of 5,69,652 vehicles on them. The traffic count data is shown in Table 1.

Table 1. Vehicle count data

Vehicle Type	No. of Vehicles
2W	341394
3W	107270
Car	93454
4W	27534
Total	569652

Source: Green Health Foundation, 2018

According to Indian Road Congress (IRC) specifications (IRC-65 1976), a rotary may be circular, elliptical, oval, or rectangular with four approach roads or legs, or it may be a complex intersection with numerous approaches. Prior studies on the capacity of an existing rotary or the design of a new rotary have largely concentrated on crossings with

only four legs intersecting at nearly equal angles. IRC regulations state that it is simple and straightforward to create such rotaries with only four legs intersecting at right angles. As seen in Fig. 1, the chosen crossroads has four approach routes. Ganesh Colony Road to Chitra Chowk and Shashtri Tower Chowk to Swatantra Chowk connect at the junction, and all of the approach roads have two-way traffic. Traffic is currently controlled by a signal or traffic police, which causes congestion during rush hours. It is crucial to have knowledge of the traffic volumes coming from the approach roads in order to build the rotary. A manual data collection was done for this, the specifics of which are described in the section below.

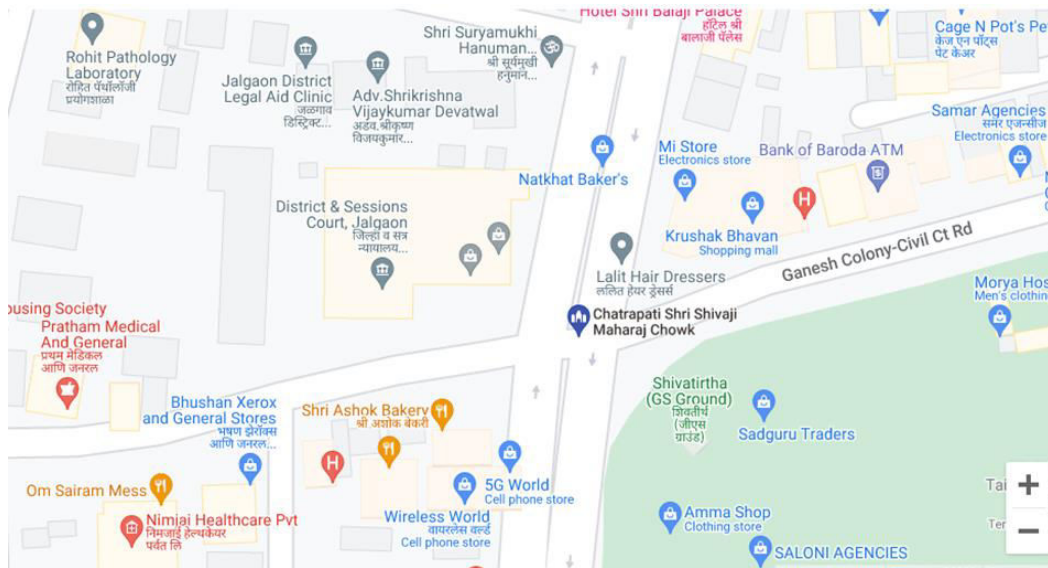


Fig.1 Map showing the study location

II. DATA COLLECTION AND ANALYSIS

Data was collected to determine the current traffic volumes, which is the most important factor in roundabout design. The data was collected for eight hours on a typical working day, from 9:30 am to 1:30 pm in the morning and from 4 pm to 8 pm in the evening, using manual counting from the veranda of a building near the intersection. Figure 2 shows a sample of the snapshot that was obtained. The intersection experiences traffic congestion during peak hours, as there are no traffic signals or police to regulate the flow of vehicles. Each 15-minute traffic volume was extracted for all five classes of vehicles considered, namely: car and light commercial vehicle (including three-wheelers), buses and medium and heavy commercial vehicles, motorcycles and scooters (two-wheelers), pedal cycles, and animal-drawn vehicles. A total of 16 directions of traffic movement were considered when obtaining the 15-minute traffic volume data. Table 1 lists the directions that were considered. The class-wise traffic volumes collected from counting were converted to passenger car units (PCU) using the PCU factors specified in IRC recommendations.



The PCU factors considered is shown in Table 2.

1	Car and light commercial vehicle (including three wheeler)	1
2	Buses and medium and heavy commercial vehicle	2.8
3	Motor cycle and scooter (two wheeler)	0.75
4	Pedal cycle	0.5
5	Animal drawn vehicle	4 to 6

Table 2. PCUs values for different vehicles as per IRC 65-1976

To determine the morning peak hour volume, the number of PCUs for each 15-minute period—9.30 am to 9.45 am, 9.45 am to 10 am, etc.—was calculated until 1:30 pm. The similar method, from 4 pm to 8 pm, a 15-minute traffic interval was estimated to determine the volume during the evening peak hour. The details of the rotary's design, which was based on observed peak hour values, are provided in the following section.

Table 3. Observed traffic movements at the selected intersection

Sr.No.	From	To
1	Ganesh Colony (West)	Shashtri Tower Chowk (North)
2		Swatantra Chowk (South)
3		Chitra Chowk (East)
4	Shashtri Tower Chowk (North)	Ganesh Colony (West)
5		Chitra Chowk (East)
6		Shashtri Tower Chowk (North)
7	Chitra Chowk (East)	Shashtri Tower Chowk (North)
8		Chitra Chowk (East)
9		Swatantra Chowk (South)
10	Swatantra Chowk (South)	Ganesh Colony (West)
11		Shashtri Tower (North)
12		Chitra Chowk (East)



Fig 2: Snapshot showing vehicles coming from different approach roads at the selected intersection

IDENTIFICATION OF PEAK HOUR TRAFFIC VOLUME

The hourly traffic volumes from 9.30 am to 1.30 pm and 4.00 pm to 8.00 pm are shown in Fig.3 and 4 for morning and evening hours respectively

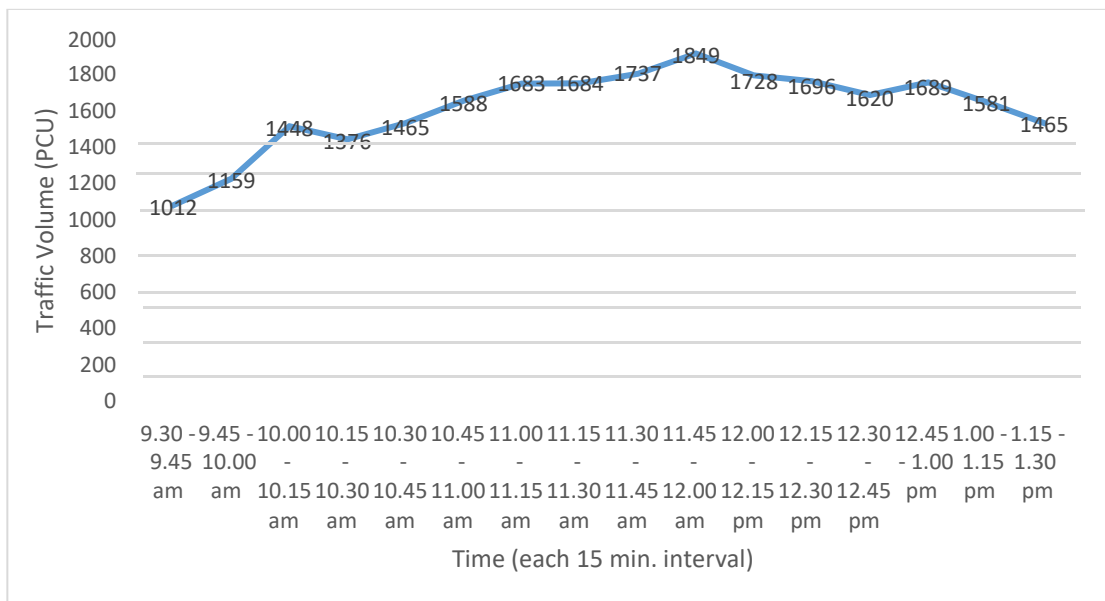


Fig 3. Hourly traffic volumes between 9.30 am to 1.30 pm

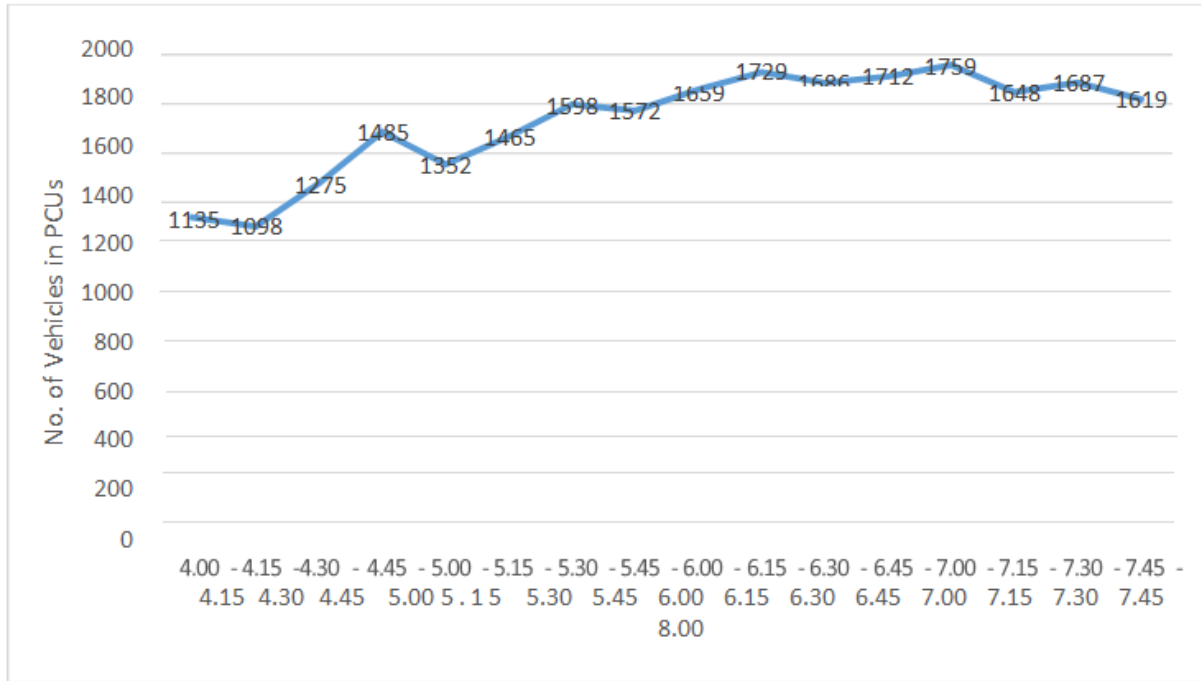


Fig 4. Hourly traffic volumes between 4.00 pm to 8.00 pm

It was discovered that the traffic volume between 11.30 am and 12.30 pm was 7010 PCUs, which is the highest hourly traffic volume during the morning hours. Similar to the afternoon peak, a maximum traffic volume of 6886 PCUs was seen in the evening between 6.15 and 7.15 pm. accordingly; the findings indicated that the greatest traffic flow throughout the eight-hour study period was 7010 PCUs, which was taken into account in the rotary's design.

III. DESIGN OF ROTARY INTERSECTION

The design of the roundabout for the selected intersection was performed according to the IRC guidelines. The first step in the design is to identify the peak hour traffic volume, which was found to be 7,010 PCUs for the case study intersection. The direction-wise traffic volume in PCUs is shown in Figure 6.

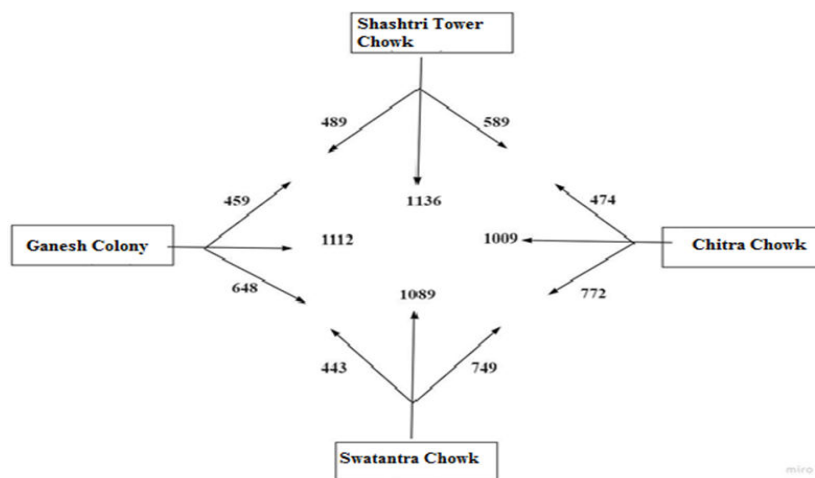


Fig 6. Traffic Approaching the Roundabout in (PCU)

The traffic volume on the Old Bypass Road is very high, both from north to south (1,136 PCU) and from south to north (1,089 PCU). Figure 6 shows that the sum of the inflow and outflow volumes on the Chitra Chowk (East) is the highest, at about 3,404 PCU. According to Kadiyali, the practical capacity of the roundabout should be greater than this value for the design to be satisfactory.

The next step is to determine the diverging, merging, and weaving traffic from each of the five approach routes. This will help identify the section with the highest proportion of weaving traffic (p), which is the ratio of the sum of crossing streams (b + c) to the total traffic (a + b + c + d).

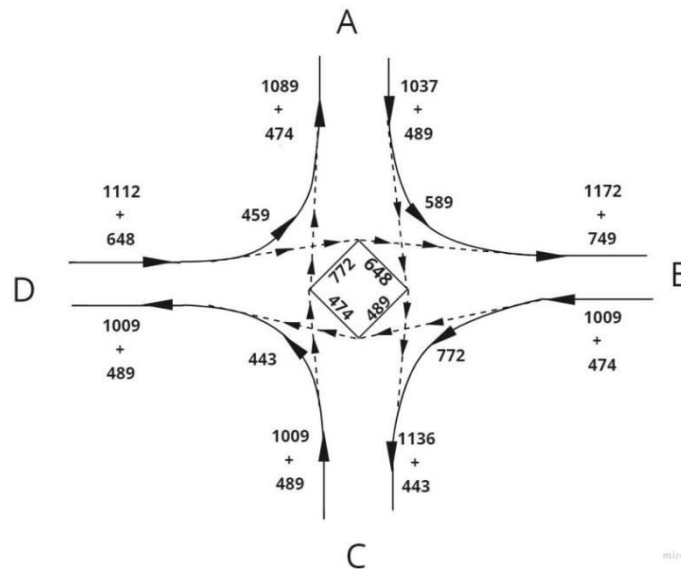


Fig 7. Traffic negotiating the Roundabout

The intersection with the highest proportion was discovered to be Swatantra Chowk (south) and Ganesh Colony (west). That is

$$PCD = \frac{(b+c)}{(a+b+c+d)} = \frac{(1009+489)+(1089+749)}{(1009+489+443+1089+749+474)} = 0.78$$

The proportion of weaving traffic (PCD) can take any value between 0.4 and 1 according to the Indian Road Congress (IRC) recommendations. The computed value in this study, 0.78, is within the prescribed limit.

The next stage is to determine the practical capacity of the roundabout under the specified geometric parameters and weaving traffic percentage to total traffic. The following empirical formula is used to calculate the capacity of a roundabout:

$$Q = \frac{280w * (1 + (\frac{e}{w})) * (1 - \frac{Pmx}{3})}{1 + (\frac{w}{L})}$$

Where,

e - average entry and exit width, i.e, (e1+e2)/2 ,

w - weaving width,

L - length of weaving, and

p - proportion of weaving traffic to the non-weaving traffic

The proportion of weaving traffic on the roundabout was 78%. The average entry width of the roundabout was 7 m, and the weaving section width was 10.5 m. The weaving length was estimated to be 42 m. The practical capacity of the roundabout was estimated to be 2900 PCU/hr, which is within the prescribed limit of 3000 PCU/hr. Therefore, the design can be deemed adequate for handling the current approach traffic volumes. In addition to the above, other factors that can affect the practical capacity of a roundabout include the number of lanes on the roundabout, the speed limit, and the presence of traffic signals.

$$Q_p = \frac{280 * 10.5 * (1 + 7) * (1 - 0.78)}{10.5 * 3} = 2900 \text{ pcu/hr}$$

$$1 + \frac{10.5}{(42)}$$

As per IRC for the effective Traffic Movement, The capacity of rotary should not exceed 3000 PCU. Hence, the design can be deemed adequate for handling current approach traffic volumes. Finally, the suggested rotary intersection was sketched out as shown in fig. 8.

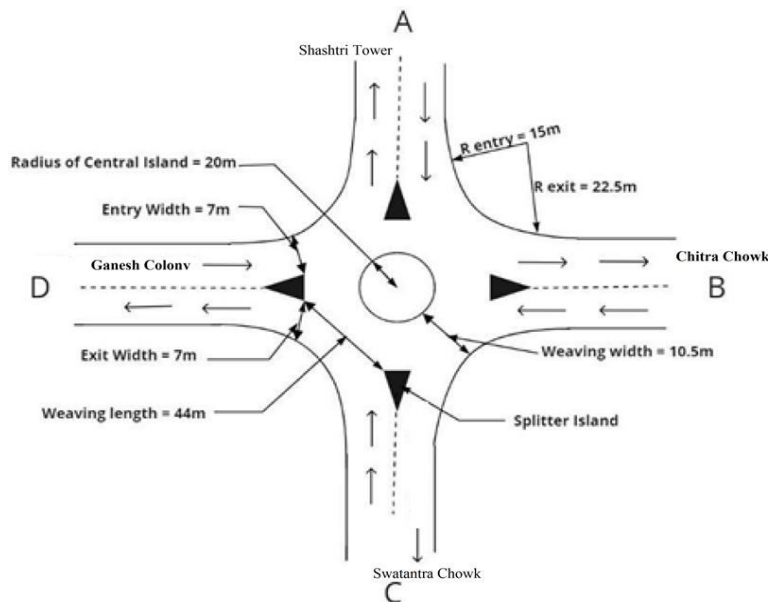


Fig 8. Design Parameter of Proposed Rotary

IV. CONCLUSION

Modern urbanization is a major problem in many Indian cities. The number of vehicles on the road is increasing as people move from rural to urban areas. However, infrastructure development is not keeping pace with the growth of vehicles, leading to traffic congestion on urban highways. Reduced use of public transportation is also exacerbating the traffic problem. One way to control traffic at crowded intersections is to construct a roundabout or rotary intersection. In this study, Manual Counting techniques were used to obtain traffic volumes from several approach routes. These traffic volumes were then analysed for peak hour traffic flow. Using this information, an attempt was made to design the rotary intersection according to IRC requirements. Finally, a drawing illustrating various design components for the proposed rotary intersection was prepared. Rotary intersections are a cost-effective and efficient alternative to grade separators. They can help to improve traffic flow and reduce congestion at crowded intersection.

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