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Performance Assessment of Six Leg Rotary Intersection Capacity

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Abstract

An Assessment of study was conducted at Six Leg rotary intersection (Medical Roundabout) in Nagpur City, Maharashtra state. (Medical Roundabout) experienced daily and frequent concurrent delay, accidents, queue built up at morning and evening peak hours. Traffic count was carried out at the roundabout to determine the movement of vehicle from the different approaches of the roundabout. The problems in delay, congestion, accident encountered were not resulted from inadequate capacity of the roundabout rather its due to high traffic flow from the intersecting legs. Traffic volume data (incoming and outgoing) from each approach road is evaluated. For this, data collection is carried out for a peak hour. During data extraction stage, traffic volume was extracted for all the different classes of vehicles considered and were converted to passenger car units (PCU). Using the calculated values of average entry width of the rotary and width & length of weaving section, the practical capacity of the rotary is estimated.

Keywords: Roundabout, weaving capacity, traffic volume

1. Introduction

Intersections are the most critical points from capacity, congestion and safety viewpoints for the operation of an urban road network and have implications on the socio economic workings of a city. A traffic rotary or a roundabout is a special form of at-grade intersections wherein a unidirectional flow of traffic takes place around a large central island before the vehicles can weave out of traffic flow into their respective directions radiating from the central island. In India, 'keep to the left' regulation is followed and also clock-wise direction of flow around the central island is followed. 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.

2. Need for the Study

The main purposes of Rotary intersection are to provide ease of traffic movement, reduction in road traffic conflict and accidents at intersections. But unfortunately at Medical Square (Six Leg Intersection) Nagpur roundabouts, frequent and concurrent delay, accidents, queue built up are experienced on daily basis especially evening hours, which crippled the facilities to serve the above primary functions,

therefore to overcome these challenges, there is need for a performance assessment studies in the bid to unveil the causes of these challenges.

3. Aim and Objectives

3.1. Aim: The aim of this research paper is to assess the performance capacity of Medical Square (Six Leg Intersection) Nagpur City, Maharashtra, India

3.2. Objectives: The objectives of this research include:

- i). To analyze the traffic volume of each approach leg.
- ii). To carry out assessment of intersection, which includes traffic volume count, weaving sections, directional flow of traffic.
- iii). To determine flow stream of Weaving Section and capacity of rotary Intersection

4. Study Area

Nagpur is precisely at the geographical center-point of India and the zero-mile marker is located. It is also one of the country's most industrialized cities. The roundabout at Medical Square is a well-designed roundabout with six Legs and heavy traffic during peak hours. The present study aims to analyze capacity of rotary intersection (Medical Square at Nagpur, Maharashtra state, India) for an uncontrolled six leg intersection located in Nagpur India. The intersection has six

approach roads with two-way traffic in all the approach roads as shown in Figure 1 and there is no signal or traffic police to

control the traffic at present and hence experiences traffic chaos during peak hours.



Fig 1: Location of Medical Square

4.1. Geometry of Roundabout: It is the prime factor which is considered for forming a model. The change in geometry leads to great change in its performance. Thus, dissimilarity in terms of size of Central Island, number of

approach legs and width of legs is important point of consideration. Geometric of rotary at Medical Square is presented in Table No.1

Table 1: Geometric of Rotary at Medical Square

Site Name	Leg	ER (m) entry radius	AW(m) Approach width	EW(m) entry width	D (m) diameter of central island	WW (m) weaving width	WL (m) weaving length	Ø (Degree) entry angle
Medical Square	Leg 1	27.51	10.38	10.79	42.82	28.65	36.77	49
	Leg 2	27.51	10.38	10.79				
	Leg 3	10.24	8.46	13.62		22.63	30.89	59
	Leg 4	10.24	8.46	13.62				
	Leg 5	23.63	8.94	10.90		18.83	37.73	44
	Leg 6	23.63	8.94	10.90				

5. Traffic Analysis

Data collection comprised of collecting the traffic data at the study area, which is required to analyze the roundabouts in that areas. For the purpose of analysis, the traffic data was collected at each approach Leg during peak hours. The data was collected in form of video recordings of the traffic flow for 1 hour during the peak hours on both working and holiday, which made it easy for the data to be extracted in continuity. The video thus recorded provides the data of number of lanes of the roundabout, their direction, entry flow through each

lane, circulating flow for each lane and also the exit flow. It also provides the data about the type of traffic and predominant mode of transport at Intersection.

5.1. Traffic Volume Count

The total traffic volume in PCU per hour emitting from all the six legs for Morning/Evening hours on working day/holiday is calculated and sample calculation for morning hours on working day from is presented in Table No. 2.

Table 2: Traffic volume in PCU per hour Morning hours on working day

PCU per Hour (Working) Morning							
Approach	PCU in Hour						
	LEG 1 (Baidyanath Square road)	LEG 2 (Ashok square road)	LEG 3 (Baidyanath Square road)	LEG 4 (Krida square road)	LEG 5 (Tukdoji square road)	LEG 6 (Rambagh square road)	TOTAL
From LEG 1	-	166	165	190	225	200	946
From LEG 2	259	-	263	272	330	301	1425
From LEG 3	318	297	-	267	272	280	1434
From LEG 4	372	272	228	-	300	353	1525
From LEG 5	220	264	256	183	-	197	1120
From LEG 6	338	321	289	266	272	-	1486
Grand Total	1507	1320	1201	1178	1399	1331	-

Total traffic volume in PCU per hour (OUTGOING and INCOMING) from all these six legs of working and holiday is shown Table 3 and Table 4 below. Ratio of outgoing and incoming traffic is evaluated on Working and Holidays and presented in Table No. 5

Table 3: Traffic volume on each Leg of Rotary working day in peak hrs

Working Day	Type of traffic	Peak hrs	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6
Traffic Volume in PCU/hr	Outgoing	Morning	946	1425	1434	1525	1120	1446
		Evening	1570	1364	1364	1512	1340	1083
Traffic Volume in PCU/hr	Incoming	Morning	1507	1320	1201	1178	1399	1331
		Evening	1504	1328	1243	1238	1535	1385

Table 4: Traffic volume on each Leg of Rotary holiday in peak hrs

Working Day	Type of traffic	Peak hrs	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6
Traffic Volume in PCU/hr	Outgoing	Morning	640	752	1199	816	883	681
		Evening	746	980	1405	953	1077	779
Traffic Volume in PCU/hr	Incoming	Morning	987	869	674	746	750	945
		Evening	1212	1048	816	880	929	1055

Table 5: Comparison of Ratio of Outgoing to Incoming Traffic volume

Ratio of Outgoing and Incoming Traffic volume in PCU/hr	Type of traffic	Peak hrs	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6
	Working Day	Morning	0.63	1.08	1.19	1.29	0.80	1.08
		Evening	1.04	1.02	1.09	1.22	0.87	0.78
	Holiday	Morning	0.64	0.86	1.77	1.09	1.17	0.72
		Evening	0.61	0.93	1.72	1.08	1.15	0.73

5.2. Capacity of Rotary

The practical capacity of the rotary is depends on the minimum capacity of the individual weaving section. The capacity is calculated from the following formula:

$$Q_p = \frac{280w(1 + e/w)(1 - p/3)}{1 + w/L}$$

Where,

Qp = Practical capacity of the weaving section of a rotary in PCU per hour

w = width of weaving section (6 to 18m)

$$w = \frac{e1 + e2}{2} + 3.5 \text{ m}$$

e = Average width of entry e1 & width of non-weaving s/c e2 for the range e/w = 0.4 to 1.0

L = length of the weaving s/c btw the ends of channelizing islands in meter for the range of

w/L = 0.12 to 0.4.

P = Proportion of weaving traffic given by

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

Where, a = left turning traffic moving along left extreme lane.

d = right turning traffic moving along right extreme lane.

b = crossing traffic turning towards right while entering the rotary.

c = crossing traffic turning towards left while leaving the rotary.

Capacity assessment of a rotary is done by analyzing the section having the greatest proportion of weaving traffic. The Traffic approaching from all six Legs on working day and Holiday in morning/evening peak hours are calculated. The way in which it is calculated is shown in detailed for each condition i.e. working evening, working morning, holiday evening and holiday morning. Sample calculations for working day (evening peak hrs) are shown in Figure 2. For working day (evening peak hrs), the incoming and outgoing traffic, weaving volume calculations are shown in negotiated diagram as Figure 3.

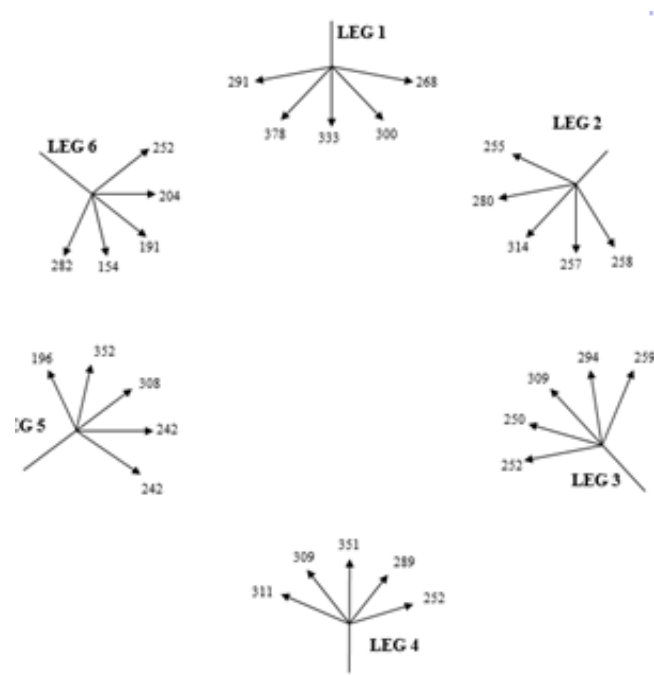


Fig 2: Traffic Approaching the Rotary on Peak Hour at Working Day (Evening)

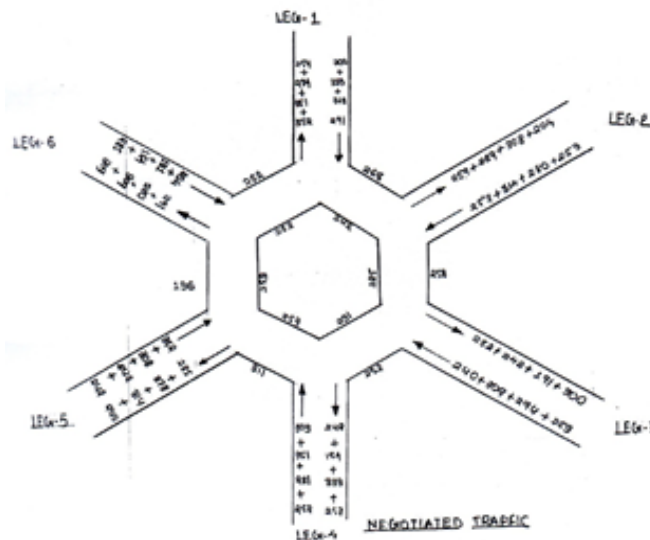


Fig 3: Negotiated traffic Working day (Evening)

6. Conclusions

From the analysis of traffic volume, the capacity of weaving sections are:

Working (Morning)

- i). Baidyanath square road to Ashok square road comes out 4449 PCU/hr.
- ii). Ashok square road to kreeda square road comes out 4316 PCU/hr.
- iii). Ajni square road to Rambagh square road comes out 3986 PCU/hr

Working (Evening)

- i). Baidyanath square road to Ashok square road comes out 4532 PCU/hr.
- ii). Ashok square road to kreeda square road comes out 4340 PCU/hr.
- iii). Ajni square road to Rambagh square road comes out 4017 PCU/hr

Holiday (Morning)

- i). Baidyanath square road to Ashok square road comes out 4511 PCU/hr.
- ii). Ashok square road to kreeda square road comes out 4277 PCU/hr.
- iii). Ajni square road to Rambagh square road comes out 4128 PCU/hr

Holiday (Evening)

- i). Baidyanath square road to Ashok square road comes out 4449 PCU/hr.
- ii). Ashok square road to kreeda square road comes out 4238 PCU/hr.
- iii). Ajni square road to Rambagh square road comes out 4128 PCU/hr

It is observed that, the traffic approaching at intersection is more IRC limit

Recommendations

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

- a. Drainage system should be improved for the better movement of vehicles and pedestrians in the rainy season.
- b. Proper installation of street light should be preferred.
- c. The extra length provided around the rotary should be used for the extension of lanes.
- d. Leg 3 and 4 should be widened so that it can cater the more exit vehicles.
- e. Existing Parking along edges of pavement on all approaches is required to be removed immediately so as to reduce congestion and traffic jams in peak hours.

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