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Operation Analysis of Roundabouts under Various Traffic Flow Conditions in City

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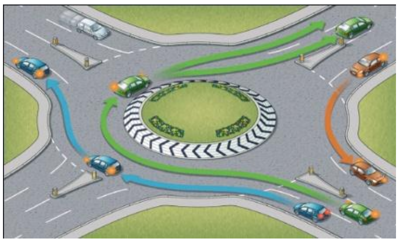
Abstract - *In this thesis project we show the most important element of operational performance of round about traffic intersection in Indore on capacity analysis traffic movements of the various vehicles in was observed at five roundabouts along road in Indore. The gap acceptance and follow up time were estimated for cars for only peak hours analysis relation between rotary performance measure and the capacity is showed in terms of capacity is measured by the gap acceptance method which is taken by tanner based on the HCM 2010 the all data collection of vehicles were collected from chosen 5 rotary (roundabouts) in Indore this roundabouts are indirectly or directly connected to their approach lag numbers.*
Here we are showing the all data collection and calculation of this thesis this is the second paper of thesis.

1. INTRODUCTION

Roundabout is a form of traffic control intersection it is normally circular shaped its have capability to solve the traffic flow problems mainly capacity of roundabout is important because capacity is directly connected to delay level of service accidents cost of operation and also environment issues in Indore there are serving from them 10 years so there why some attention should paid to the designing and capacity factors of this all roundabouts in this project we use tanner models and gap acceptance capacity models for find out the safe gap in the traffic stream to enter the roundabouts mostly concentrates on determining the capacity of approach which is based on the centering and circulating flows in current research work on the roundabouts critical headway and follow up head way calculated as approach capacity roundabouts can classified in two categories theoretical and empirical.



1.1 AIM AND OBJECTION

The objective of this project are:

- To analyst available information of capacity of roundabouts through literature review.
- For selection of right methodology to evaluating the capacity of roundabouts for medium size cities.
- For medium size cities define the capacity and service level of roundabouts.

2. LITERATURE REVIEW

6.1 General

Siegloch was developed a linear-regression technique which used the gap data from queuing conditions to estimate both the critical gap and the follow-up headway in 1973. This technique recorded the gap with size and number of accepted vehicles. Then all data were categorized according to the number of accepted vehicles. Within each category the average gap size was calculated. As a result, a reduced data set of average gap size versus number of accepted vehicles was generated. Finally the average gap size was fit as a linear function of the number of accepted vehicles. Although being straightforward and generally giving good estimations, this method applied only to those conditions where queues appeared in the minor stream. Polus and Shmueli developed an entry-capacity model for roundabouts that includes outside diameter and circulating flow as input parameters in 1997. Six small to medium sized roundabouts in urban and suburban areas of Israel were included in this study. A separate regression model was developed for each roundabout studied because it was believed that the geometric characteristics of each site significantly affect its capacity. The capacity of each entry was defined as the maximum number of vehicles that can enter the roundabout in 1 hour under continuous queue conditions.

Hagring proposed a new capacity model for two-lane roundabouts based on previous studies (Hagring 1996, 1998) at Swedish roundabouts on the effects of origin- destination (OD) flows. The developed model was tested on two synthetic data sets and compared with another OD model proposed by Akçelik et al. (1996) and Akçelik (1997). The previous work by Hagring studied critical gap differences between the inner and outer entry lanes at two-lane roundabout approaches. A simplified model was developed relating critical gap to the length and width of the weaving section between adjacent approaches. The capacity model presented and evaluated in the current study was first developed in these older studies. Flannery et al. developed equations estimating the mean and variance of service time for a vehicle in the first position at an entry of a single-lane roundabout. With these estimates, the Pollaczek-Khintchine formula and Little's law may then be used to estimate the average number of queued vehicles and the average total waiting time per vehicle, respectively. Service time is defined as the time spent in the first position of the queue prior to entering the circulating stream and includes the time spent waiting for an acceptable gap in the circulating stream, travel time to enter the circulating stream, and the headway for the subsequent circulating vehicle.

6.2 Analytical (Gap Acceptance) Vs Empirical Regression

There exist two distinct theories depends upon roundabout capacity/delay equations. These theories are the analytical or gap acceptance method, and the empirical method, which is based on geometrics and regression.

In Kimber's initial laboratory report (1980) he states that the dependence of entry capacity on circulating flow depends on the roundabout geometry. Kimber defines five geometric parameters which have an effect on the capacity. These are entry width and flare, the inscribed circle diameter (a line that bisects the centre island and the circulating lane twice) and the angle and radius of the entry. In Kimber's 1989 paper he states that gap acceptance is not a good estimator of capacity in the United Kingdom. He also states that single-lane entries are the basis for the simplest case for gap acceptance models, while empirical models apply also to multilane entries. Kimber reasons that gap acceptance models do not increase capacity correctly when additional entry lanes are added. Kimber makes two interesting comments in his paper the first being that many circumstances exist where driver response to yield signs conforms to gap acceptance assumptions. He is not given sufficient description of gap acceptance roundabouts. The main flaw of the gap acceptance theory is that it poorly evaluates capacity for roundabouts. The second comment by Kimber is that because of driver behaviour and geometric variation is not safe to transfer theories from one country to another. Fisk, in a 1991 article, agreed that regression models should not be transferred from region to region or between roundabouts of different geometrical configurations..

6.3 Critical Gap and Follow up Time

Cassidyetal (1995) state that it is not possible to directly observe the mean critical gap. This report also states that there is no evidence that a single-valued gap acceptance function cannot be used to model driver behavior reliably at a stop sign. Tian et al (2000) consider the many variables that can effect critical gap and follow up time. They state that geometry, turning movements, vehicle type and approach grade were found to affect these parameters. The Federal Highway Administration (FHWA) (2000) states that it is not desirable to locate roundabouts where grades are greater than four percent. Therefore, it is assumed that most roundabouts will not deal with grade as a factor.

The Transportation Research Board (HCM 1997) presents its critical gap range as 4.1 to 4.6 seconds, and the follow up time as 2.6 to 3.1 seconds. These values are for only single lane roundabouts. List et al (1994) determined the average critical gap to be from 2.8 to 4.0 seconds and the follow up time to range from 1.8 to 3.7 seconds. These values were most representative of the right lane. As stated earlier, the right lane will have a smaller critical gap and follow up time than the left lane, as the vehicles in the left lane have to cross the outside circulating lane. All of these gaps are consider smaller than the recommended critical gaps and follow up times for two-way stop controlled intersections. The Transportation Research Board lists these as 6.9 and 3.3 seconds for a right turn onto a four-lane road, which is analogous to the circulatory roadway of a multilane roundabout. Roundabout gaps and follow up times are smaller due to two reasons. The first is the ability for some vehicles to enter the circulating roadway without coming to a complete stop. If there are no queued vehicles in the entry lane the yield control allows vehicles to only slow to the speed at which they can safely negotiate the roundabout. The second reason is the flare of the roundabout.

3. METHODOLOGY:

Step 1: Select the Area of Study
Step 2: Collect the data from Road Side and field observation
Step 3: Analyzed the data like capacity, degree of saturation for various models, delay, queue etc.
Step 4: Determine all independent variables.
Step 5: Determine opposing circulatory flow, capacity at legs, and Service level of Roundabouts.
Step 6: Summary, Result and conclusion.

4. DATA COLLECTION AND CALCULATION:

For the data collection of roundabouts we always take the peak hours because in peak hours traffic is maximum.

There are five roundabouts or squares of INDORE city with date and time details which is selected for research.

Roundabouts	Date	Time of Day
Rajiv Gandhi Square	09/12/2019	9:15 to 10:15 Am
Vijay Nagar Square	10/12/2019	5:00 to 6:00 PM
Sayaji Square	12/12/2019	9:00 to 10:00 AM
Regal Square	13/12/2019	9:00 to 10:00 AM
Maharaja Chhatrasal Square	16/12/2019	5:00 to 6:00 PM

After collecting the all data from the field just like number of vehicles, lines of road, Types o vehicles etc we draw tables of all collected data and calculate the Passenger Car Unit (PCU).

Table A: Summarized Vehicle Volume on each leg at peak hour

Roundabout	Leg No.	Heavy vehicles	Light Vehicles		Total	Total no. of vehicles	Total Traffic (PCU)
			Cars & Autos	Motor cycle & bicycle			
Rajiv Gandhi Square	E	10	45	87	132	142	119
	W	8	32	59	91	99	85
	N	11	26	64	90	101	91
	S	9	31	42	73	82	79
Vijay Nagar Square	E	9	44	61	105	114	101
	W	3	25	56	81	84	62
	N	6	19	49	68	74	61
	S	8	22	71	93	101	81
Sayaji Square	E	3	29	92	121	124	84
	W	5	17	54	71	76	59
	N	7	33	66	99	106	87
	S	2	24	72	96	98	66
Regal Square	E	6	51	88	139	145	113
	W	11	39	72	111	122	108

	N	10	44	76	120	130	112
	S	8	28	65	93	101	85
Maharaja Chhatrasal Square	E	13	34	59	93	106	103
	W	9	26	76	102	111	91
	N	6	30	48	78	84	72
	S	10	19	55	74	84	77

After collection of all data and calculation of PCU, Capacity, Delay, Queue length, Degree of Saturation at each leg according Tanner Model, German Model, NCHRP Report. We draw a table for Total analysis result on the intersection based on Tanner Model

Table B: Summarized Analysis result on the Intersection based on Tanner Model

Roundabouts	Total Vehicle Flow	Capacity	Delay	Queue Length	Degree of Saturation	Level Of Service (LOS)
Rajiv Gandhi Square	375	735	14.9	3.07	0.51	**B**
Vijay Nagar Square	307	666	15.1	2.52	0.46	**B**
Sayaji Square	296	572	18.05	3.17	0.52	**B**
Regal Square	418	971	11.49	2.24	0.43	**B**
Maharaja Chhatrasal Square	343	670	15.93	4.68	0.51	**B**

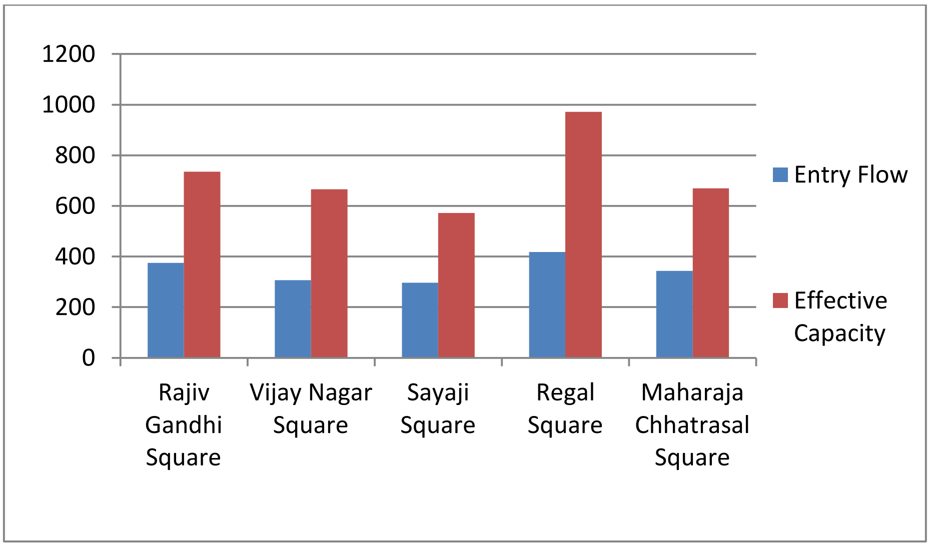


Figure A : Peak Flow vs Effective Capacity

We find out the Level of Service of the Roundabout and the road on the basis of the HCM 2010 method for Level of Service definition based on Delay and V/C for vehicle with alternative methods for Roundabout.

Table C: Summarized Analysis Result on the Approach Leg based on Tanner Model

Roundabouts	Leg No.	Total Vehicle Flow (PCU)	Capacity	Delay	Queue Length	Degree Of Saturation	Level Of Service (LOS)
Rajiv Gandhi Square	E	119	264	29.6	3.37	0.45	C
	W	86	215	32.7	1.94	0.40	C

	N	91	131	**88.10**	5.29	0.69	**F**
	S	79	125	**79.67**	4.30	0.63	**F**
Vijay Nagar Square	E	101	288	24.19	1.58	0.35	C
	W	62	98	**99.30**	4.15	0.63	**F**
	N	62	100	**93.39**	3.90	0.61	**F**
	S	81	180	41.10	2.34	0.45	D
Sayaji Square	E	84	192	37.70	2.17	0.43	D
	W	59	128	56.52	2.39	0.46	E
	N	87	133	37.27	4.80	0.66	D
	S	66	122	67.80	3.16	0.54	E
Regal Square	E	113	269	27.98	2.11	0.42	C
	W	108	432	16.10	0.99	0.25	B
	N	112	178	56.76	4.33	0.62	E
	S	84	92	**236.6**	9.57	0.92	**F**
Maharaja Chhatrasal Square	E	102	310	22.05	1.39	0.32	C
	W	91	131	**88.10**	5.29	0.69	**F**
	N	72	108	**99.67**	4.79	0.67	**F**
	S	76	121	**82.05**	4.28	0.63	**F**

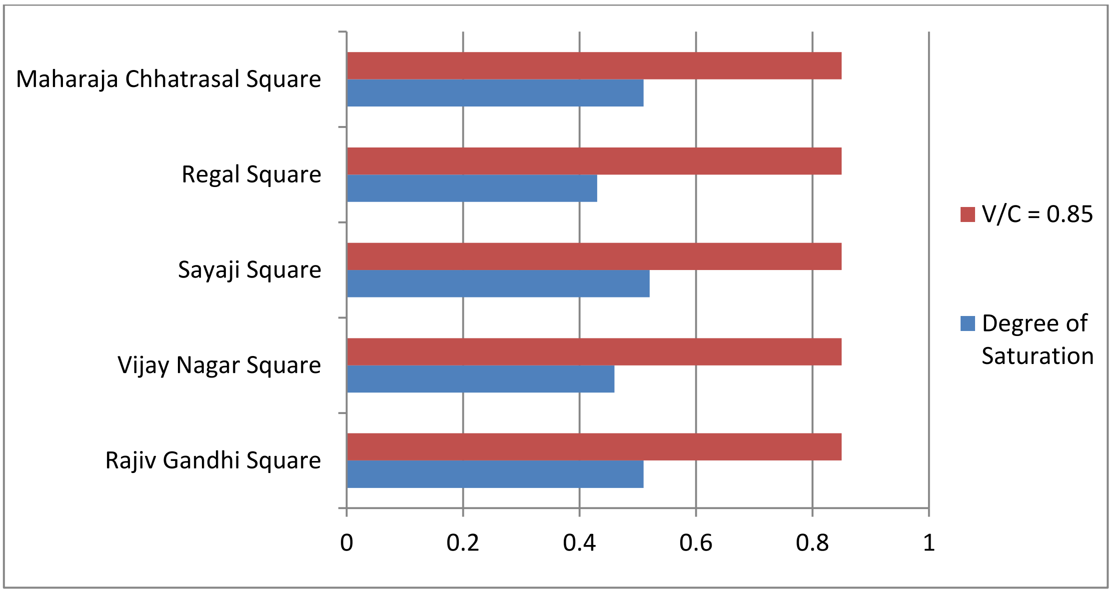


Figure B : Degree of Saturation at Intersection

5. SUMMARY AND CONCLUSIONS :

Based on the literature reviewed, different countries have their own methods of Capacity Analysis, which is sent by different researchers, but we can categorize them into totally Roundabout Geometry depends on the approach leg that is the Empirical Method. Gap acceptance approach that driver behavior, type of vehicle, circulating and entering splits and conflicting circulating flow are included in Analytical Method.

When we compare the Table A and Table B we see that when we see the total analysis result the **level of service is 'B'** for all roundabouts but when we see the result on approach leg the various legs of roundabouts are show the **'F' Level Of Service**.

Indore roundabouts capacity analysis results indicate the most of the legs of roundabouts are in serious problems or over saturation. Based on observed actual field conditions it is common to see that at peak hours, the traffic police need to regulate the traffic at these roundabouts since traffic control devices cannot function or regulate the traffic. As the study uncovered the real issues are identified with deficiency of number of entry lanes, number of circulatory lanes, high traffic flow and unbalanced traffic on the approaches roundabout. Besides most of the roundabouts were built more than 10 years ago with obscure service limits.

All the input parameters of empirical method for capacity analysis do not exist at Indore Roundabouts. Thus only analytical method was carryout the capacity analysis with parameter using Tanner Formula based on HCM 2010.

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6. SCOPE FOR FUTURE WORK:

After study or peak hour data collection for the roundabouts that have high and unbalanced traffic flow, their replacement with other junction type is suggested. The roundabouts which are located at the ring road are not providing the expected service levels. Since this device connects high-speed primary road and access road. Therefore replacement of these roundabouts by other intersection type is suggested after careful study.

Since the collected data for the analysis was limited especially regarding peak hour traffic the chart developed by this current research just understands on the subject of my exploration. In this respect, further study is prescribed with more data accumulation so as to refine the chart and for use of roundabout traffic services improvement.

REFERENCES:

1. Highway Capacity Manual (HCM 2010).

2. Trafic Emgineering and transport planning By Dr. L.R. Kadiyali.

3. Principle of Transportation Engineering By Partha Chakroborty, & Animesh das.

4. IRC: 65-1976 Recommended Practice for Traffic Rotaries.

5. NCHRP (2007) Report 572 Roundabouts in the United States.

6. Federal Highway Administration (2000) Roundabouts: An Information Guide "FHWA-RD-00-67, Department of Transportation . Washington, DC.

7. Akçelik, R. (2011). An Assessment of the Highway Capacity Manual 2010 Roundabout Capacity Model. Proceeding of the 3rd International Conference on Roundabouts, Carmel, IN, May 18-20, 2011

8. Dahl, J. and Lee, C. (2011). Factors Affecting for Capacity Estimation for Roundabouts with High Truck Volume. Proceeding of the 3rd International Conference on Roundabouts, Carmel, IN, May 18-20, 2011.

9. Polus, A., S. S. Lazar, and M. Livneh. (2003). Critical Gap as a Function of Waiting Time in Determining Roundabout Capacity. Journal of Transportation Engineering, Vol. 129, No. 5, pp. 504-509. .

10. Kimber, R.M. (1980). The capacity of roundabouts. TRRL, LR 942. 1980.

11. Polus, A., Shmueli, S. (1997). Analysis and Evaluation of the Capacity of Roundabouts. TRB Annual Meeting, Jan. 1997, Washington, Preprint 970115.

12. Tanner, J.C. (1962). A theoretical analysis of delays at an uncontrolled intersection. 49:163-170.

13. TRB (2000). Highway Capacity Manual (HCM 2000). TRB, National Research Council, Washington, D.C