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ANALYZING CAPACITY AND LEVEL OF SERVICE OF UNSIGNALIZED ROUNDABOUT

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Abstract: **Numbers of vehicle on road increases with respect to income and population, Because of this the traffic increase, and traffic analysis and planning has became essential. Traffic planning acts as nervous system of city. Better the traffic planning, greater will be the city development as well as lesser will be the traffic problems. This paper examines the use of Indo HCM 2017 in operational estimation of capacity and level of service of roundabout using field entry flow and circulatory flow. This analysis can be empirical and analytical. The estimated entry capacity and field flows were found to be higher compare to HCM estimates. This analysis tries to estimate the entry capacity of a roundabout based on the traffic flow conditions on roundabout and driver's behaviour depicted by the gaps being accepted or rejected while trying to enter circulating Flow. This also estimates the traffic flow in the measurements of vehicle per hour and PCU per hour. Observations says that entry Speed of the vehicle is lower when it enter in the roundabout, causing queues and it will directly increase fuel demand same environmental pollution, which can be a great loss to city.**

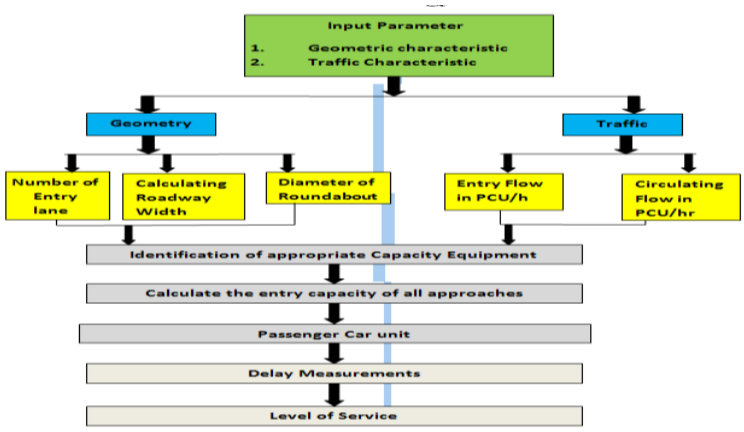
Keywords: **The estimation, circulatory flow, roundabout, Observations.etc.**

I. INTRODUCTION

A roundabout is an effective arrangement made at intersection for traffic control. Generally roundabout is circular in shape. It can be measured by entry flow and circulation around a central island. More traffic at one arm directly affects the traffic at other entering traffic. Evaluation of roundabout is very important at regular interval since it is directly related to delay and delay affect level of service, operation cost, and environmental issues. There are four legs of roundabouts in Vadodara and most of them are there from long years. Therefore capacity evaluation becomes necessary to know the current condition of the roundabout. Current work on roundabout is mostly concentrates on determining the capacity on the entry flow and circulating flow. Capacity is calculated as per the indo HCM 2017. Geometric parameters are plays important role in this method. Such as Inscribed circle diameter, entry angle, etc. In addition, the level of traffic stream performance itself can influence driver's behavior and increasing the complexity of modeling roundabout operations.

II. METHODOLOGY

A. Flowchart for operational Analysis of Roundabouts



B. Passenger Car Unit [3]

Passenger Car Units (PCUs) derived for different vehicle types, based on five important inputs namely, traffic flow, headway, conflict angle of vehicles negotiating the roundabout, vehicular speed and composition of traffic. Passenger Car Units (PCUs) derived for different vehicle types, based on five important inputs namely, traffic flow, headway, conflict angle of vehicles negotiating the roundabout, vehicular speed and composition of traffic

TABLE I: SUGGESTED PASSENGER CAR UNITS FROM INDO HCM (2017)

Diameter in m	Motorised Traffic						Non Motorised Traffic		
	Two Wheeler	Autos	Small Cars	Big Cars	LCVs	Heavy Vehicles	Cycle	Cycle Rickshaw	ADV
20 < D ⩽ 30	0.32	0.83	1.00	1.40	1.88	3.65	0.18	1.12	4.0
30 < D ⩽ 40					1.65	3.45	0.21	1.31	
40 < D ⩽ 50					1.53	3.20	0.25	1.56	
50 < D ⩽ 70					1.46	3.05	0.28	1.74	

B. Driver's Behaviour[3]

- ***Critical Gap***

Critical gap represents the minimum time interval in the circulating flow when an entering vehicle from approach can safely enter a roundabout as mentioned earlier

- ***Follow-up Time***

The time between the departure of one vehicle from the approach and the departure of the next vehicle using the same gap in circulating flow, under a condition of continuous queuing condition, is called the follow-up time.

TABLE II: CRITICAL GAP AND FOLLOW-UP TIME FOR DIFFERENT DIAMETERS OF ROUNDABOUTS INDO HCM (2017)

Diameter in m	Critical Gap	Follow up Time
20 < D ⩽ 30	2.00	1.50
30 < D ⩽ 40	1.90	1.40
40 < D ⩽ 50	1.65	1.25
50 < D ⩽ 70	1.60	1.20

C. Capacity Estimation [3]

This section presents the process for determining the entry capacity of roundabout. It may be noted by the analyst that the maximum flow rate that can be accommodated at a roundabout entry depends on two factors namely, the circulating flow on the roundabout that conflicts with the entry km flow and the geometric elements of the roundabout.

When the circulating flow is low, drivers at the entry are able to enter the Roundabout without significant delay. The larger gaps in the circulating flow are more useful to the entering drivers and more than one vehicle may enter each gap. As the circulating flow increases, the size of the gaps in the circulating flow decrease, and the rate at which vehicles can enter also decreases correspondingly.

Similarly, the geometric elements of the roundabout also affect the rate of entry flow. The most important geometric element is the width of the entry and circulatory roadways, or the number of lanes at the entry on the roundabout. Two entry lanes permit nearly twice the rate of entry flow as that of a single lane. Wider circulatory roadways allow vehicles to travel alongside, or follow, each other in tighter bunch and so provide longer gaps between bunches of vehicles. The flare length also affects the capacity. The inscribed circle diameter and the entry angle have minor effects on capacity.

Fig.1 demonstrates the methodology devised for the estimation of entry capacity of the roundabout. The capacity of roundabout is a function of entry flow and circulating flow. As driver behaviour Roundabouts CSIR - Central Road Research Institute, New Delhi Page 7 – 12 appears to be a significant variable affecting roundabout performance,

consideration of critical gap and follow-up time is recommended to produce accurate capacity estimates. The following exponential model(s) adopted from HCM (2010) can be used by the analyst for the estimation of entry capacity of roundabout:

$C = A * Exp (–B*Qc)$ Equation 1

$A = 3600/Tf$ Equation 2

$B = (Tc – 0.5*Tf)/ 3600$ Equation 3

Where,

Tf = Follow-up time in seconds

Tc = Critical Gap in seconds

Qc = Circulating flow in PCU/hour

Using the average critical value and follow-up time presented in the earlier section, the entry capacity models / equations for varying range of diameters of roundabouts have been derived and presented in Table 3

TABLE III: Entry Capacity Model for Varying Diameters of Roundabout

Diameter in m	Critical Gap, T_c (s)	Follow up Time T_f(s)	$A=3600/T_f$	$B=(Tc – 0.5*Tf)/ 3600$	$C = A* Exp (-B*Q_c)$
$20 < D \leqslant 30$	2.01	1.51	2384	0.00035	$C = 2384*Exp (-0.00035*Q_c)$
$30 < D \leqslant 40$	1.87	1.40	2571	0.00032	$C = 2571*Exp (-0.00032*Q_c)$
$40 < D \leqslant 50$	1.65	1.24	2903	0.00029	$C = 2903*Exp (-0.00029*Q_c)$
$50 < D \leqslant 70$	1.61	1.21	2975	0.00028	$C = 2975*Exp (-0.00028*Q_c)$

D. Level Of Service [3]

The estimation of LOS is based on the delay model derived from studies conducted on Multilane roundabouts of varying diameter by taking into account the delay experienced by The vehicle from entry point to reach the exit point of the roundabout.The delay model empirically derived is as presented in Equation.

$y= 0.8*e0.001x$

Where,y= Vehicular Delay in seconds.

x= Total Approach Traffic Flow in Veh/h.

TABLE IV: Entry Capacity Model for Varying Diameters of Roundabout INDO HCM 2017

LOS	Average Delay ‘d’ per Vehicle (Sec)
A	$\leqslant 5$
B	$6 \leqslant d \leqslant 15$
C	$16 \leqslant d \leqslant 20$
D	$21 \leqslant d \leqslant 35$
E	$36 \leqslant d \leqslant 65$
F	$\leqslant 65$

E. Site Information

A roundabout is an effective arrangement made at intersection for traffic control. Generally roundabout is circular in shape. It can be measured by entry flow and circulation around a central island. Roundabouts are good solution 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 four legs

roundabouts in Vadodara and most of them are there from long 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. Geometric parameters are important in this method. Such as Inscribed circle diameter, entry angle, etc. In addition, the level of traffic stream performance itself can influence driver's behavior and increasing the complexity of modelling roundabout operations.

TABLE V: Input parameter

Parameter	Description	observation
Geometric Characteristics	1. Diameter of the roundabout in m	20 m
	2. Number of Approach Lane	2
	3. Approach width in m	12.75 m
	4. Number of circulating lanes	4
	5. Circulating roadway width in m	21 m
Traffic Characteristic	4. Entry Flow in veh/h (Qe)	Video Extraction
	5. Circulating Flow in veh/h (Qc)	
	6. Passenger Car Unit (PCU)	Conversion of traffic flow in PCU
	7. Entry Flow in PCU/h (Qc)	
	5.Circulating flow in PCU/h (Qc)	
Driver Behavior	1.Critical Gap, Tc (sec)	Computation is below
	2. Follow-up Time, T1 (sec)	

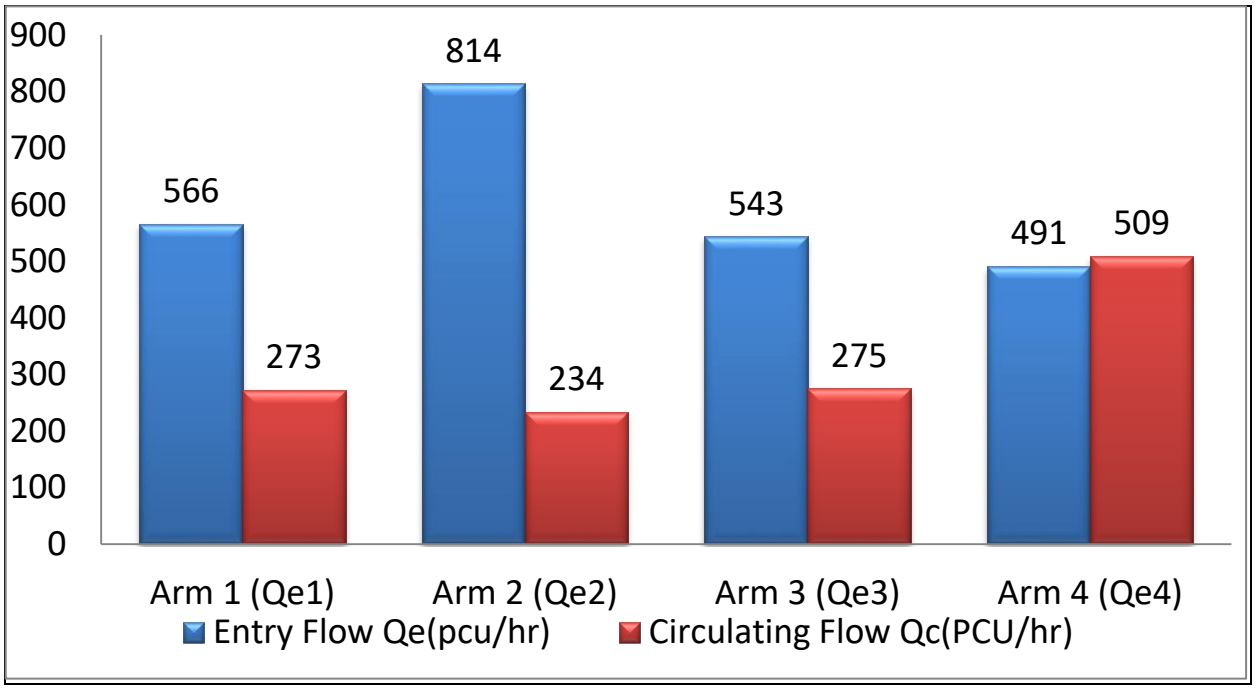


Figure.1 Entry Flow & Circulating Flow PCU/hr BY Using PCU values for different modes presented in Table 1 (Wide diameter range)the above roundabout falls in the range of 20 m - 30 m and accordingly table 2 list the pcu values considered

- Highway research Special report 87 For 4-Lane road Traffic capacity in one direction 1400-1800 PCU/hr
- BY Using PCU values for different modes presented in Table 3.4 (vide diameter range)the above roundabout falls in the range of 20 m - 30 m and accordingly table 3.2 list the pcu values considered
- D Conversion of traffic flow to PCUs/hr
- Using the pcu values the entry flow and circulating flow is presented in table

Figure.2 Google image of the Roundabout

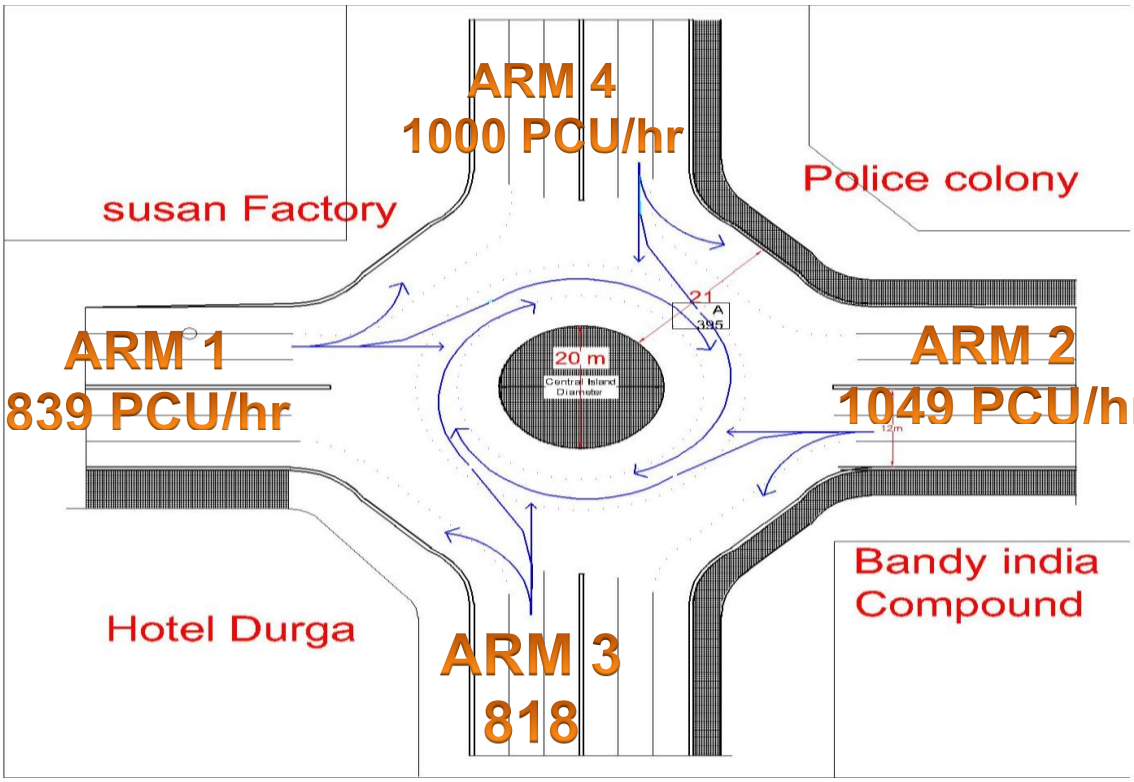


Figure.3 Capacity of flow in PCU/hr at Different arm of Roundabout

III. RESULT

Result level of service of Susan circle falls in E categories

Authority need to take serious action to improve is Traffic planning

- Route Arm 1 to Arm 3 having maximum flow of traffic.
- Main user of this circle is heavy vehicles and workers of Makarpura GIDC so on that route traffic is more.
- The arm 3 to 4 is having connectivity to NH8 so speed is much slow at roundabout it will directly affect efficiency of route.
- Extreme slow traffic increase fuel consumption.
- The traffic volume study analysis gives the result need for the improvement in the Roundabout capacity to approximately all the routes.

- To cope with the improvement in Roundabout capacity, there should be improvement in the design features of the Roundabout junction
- The traffic volume study analysis gives the result need for the improvement in the Roundabout capacity to approximately all the routes.
- Heterogeneous traffic is there so again need more attention

IV. CONCLUSION

As per the guideline of HCM the traffic value falls in the limit. Due to improper management delays accurse on the roundabout. The Design of roundabout is ok but geometry of roundabout is not fulfilling the purpose of roundabout. Illegal parking, queuing of street vender and illegal advertisement board reduce the space of roundabout. Therefore traffic engineer needs design methods based on fundamental relationships between geometry, capacity and safety that will enable 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;
- Driver's behaviour affects the capacity of roundabout.
- Roundabout evaluation needs periodically for the improvements and 23e the better movement of vehicles and safety of motorists and pedestrians.
- So complete geometry of roundabout by providing curb in the direction of flow.
- Proper Channelization is good option to improve capacity of Roundabout.
- Provide sign board near roundabout.
- Heavy Commercial Vehicles must have time limit for entry. Heavy commercial vehicle are must have to avoid peak hour timing.
- Grade separation option will be long term solution.

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