INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE
ISSN: 2057-5688

Estimation And Valuation of Capacity and Level of Service at Unsignalized Intersection

[1]Dr. P. SUDHA RANI, [2]AZMEERA DEVENDAR NAIK, [3]KANUKUNTLA SAI SREE, [4]JILUKARA JYOTHI, [5]BODDU SRINIVAS KALYAN

[1]Professor, Dept.of CIVIL ENGINEERING, Guru Nanak Institute of Technology, Hyderabad, psudharani.cegnit@gniindia.org

[2,3,4,5]BTech Student, Dept.of CIVIL ENGINEERING, Guru Nanak Institute of Technology, Hyderabad

azmeeradevendarnaik@gmail.com, kanukuntlasaisree123@gmail.com, jyothijilukara@gmail.com, Srinivaskalyan521@gmail.com

Abstract: *The capacity of an unsignalized intersection is defined as the maximum number of vehicles that can pass in one direction or one approach of an intersection. It has been assumed that there are no delays in priority movements, except when pedestrians interrupt the flow. At unsignalized intersections, the interaction of vehicles is very complex. The capacity and level of service at uncontrolled unsignalized intersection is very important in developing countries. In developed countries, the intersections are controlled by using different methods like giving signs to the vehicles or by constructing different lanes of roads for different types of vehicles at the intersections but in India all the vehicles do use the same lane which is considered as complex traffic conditions. We consider the different aspects about the driver's behaviour. In general signals are provided instead of signs, due to rapid increase in traffic continuously. At this type of intersections few vehicles are moving without following any traffic conditions. Violation of traffic rules and regulation may lead to accident and conflict movements. Providing signals at each and every unsignalized intersection is very costly.*

Keywords: Capacity, Critical gap, Level of service, HCM-2010, Complex traffic conditions, Control delay, T-Intersection, Vehicles movement.

I. INTRODUCTION

Intersections of street at grade in urban areas are critical portions of high way because these are the primary sites of traffic accidents and points of considerable congestion and delay. Capacity at

ISSN: 2057-5688

unsignalized intersections is defined as a result of the essential capacity within ideal traffic conditions associated with various adjustments and correction factors, including the impact of the road environment, geometric design and traffic conditions. Although there have been several considerable researches conducted on the operation of signalized intersections, comparatively a very few studies have been examined on the operation of unsignalized intersections. In major countries left-turn moments are used in contrast to that in india the straight or the rightturn moments are used. These are the major source of vehicular conflict resulting in delay, congestion and accident. To minimize these vehicular conflict we need to improve the design and operation of unsignalized intersection. Improvement of this design depends upon the accurate capacity and the delay estimated in response to alternative styles and policies. Two-Way Stopped-Control (TWSC) intersections are very common type of intersections, the minor road is controlled by stop signs and the approaches haven't controlled by any signs referred to as major street approaches. A three-legged intersection is considered as a standard typeof TWSE Intersection or T-Intersection. In this type of intersection a street road and the vehicles are merged or cross the major street road with stop signs are installed on minor road. The capacity service for these intersections is based on relative priorities of the conflicting moments. At these intersections merging, crossing, diverging of traffic is very complex which results in delay. So, these types of intersections are very risky and challenging. At an unsignalized intersection, each driver should find a safe moment for the turning moment of the vehicle depending upon the traffic conditions and pertinent regulations. Gap acceptance is a process in which a minor street vehicle accepts an available gap. These is the to accept or reject the gap. The minimum gap is required in major stream for the minor stream Vehicle to cross the intersection safely is known as critical gap. All the drivers to reject the gaps which are less than critical gap and only the gaps which are more than critical gap are accepted. The maximum number of vehicles that can pass in one direction or one approach of an intersection is called the capacity of an unsignalized intersection. The capacity is a quantitative parameter, it is based on HCM manual by using parameters like critical gap and flow up time. It is essential to analyse the capacity at uncontrolled intersections and to improve the service of intersections. The extra time consumed by the vehicle than the reference values or additional travel time experienced by driver, passenger or pedestrian is called delay, which is a fundamental parameter for highways investments. At unsignalized intersections inversed capacity of vehicles is occurred.

II. LITERATURE SURVEY

Raffs method was introduced by Raff in the year 1950. A simulation model was developed by popat et al. (1989) for T-intersection. This model was developed to give relationship between flow on major and minor roads, mean delay, total delay, queue lengths and the critical gap is considered as constant four seconds. It was concluded that, minor road vehicles enter's the major road traffic, if the available gap is greater than four seconds or else the vehicle will wait or slow down. The gap was defined differently by various researchers. According to them the details of gap and lag are briefly given below:

- Ashworth and Green in the year 1966 measured the gap from rear of one vehicle to the front of the following vehicle.
- The researcher Adibesi in the year 1982 measured the gap as the major stream headway wholly available to a waiting vehicle from the minor road.
- Based on Polus (1983), it was the time interval between two successive vehicles in the major road stream. The lag is measurement between two vehicles on different roads. They are different Studies done for measuring of gap, lag, critical gaps. In these studies, it is determined at unsignalized Intersections.
- Intersections with priority of vehicle concept include

Various methods were introduced and being evaluated based on the conditions that results of the estimation process should not depend on traffic volume on the major approach during the time of observation. The estimation is being applied on the basis of under saturated traffic conditions at unsignalized intersections on fulfilment of the conditions.

Greenshields et al determined in the year 1947 that the critical gap is the acceptable average minimum time gap. Later in 1950's maiden discovered an empirical method to estimate critical gap by applying

ISSN: 2057-5688

regression analysis. Raff and hart defined critical gap as the lag for which the number of accepted shorter gaps is equal to the number of rejected longer than it. The critical gap was measured using some of the existing methods such as lag, Harder, log modified Raff and Hewitt method at unsignalized T-intersections by Aashalatha in the year 2011. The critical gap variation by these methods highlights the incapability of the existing methods to address the mixed traffic conditions.

Sai et al in the year 2014 found that the capacity of any uncontrolled intersections of Indian, was highly depends on the gap acceptance behaviour. In his study, a micro second difference in gap measurement leads to considerable error in capacity estimation. so, they concluded that the majority of the gaps were between 0-2 seconds. The analysed formulas for the calculation of mean queue lengths and average delays for vehicle on the minor roads at priority intersections was introduced by Heidemann in 1991 This method is considered to be a popular method among many researches and it is found from the intersection of cumulative probabilities of accepted and rejected gaps. The graphs were plotted between % cumulative accepted and rejected gaps.

III. METHODOLOGY

In this methodology, it includes the inputs like, Geometric data, Hourly volumes, Heavy vehicle percentages. The number of vehicles, type of vehicles are counted in each direction accurately. The hourly turning movement of volumes are observed based on conducted survey. The peak hour volume is decided based on the observations of naked eye. From this data, the % of sharing of different types of vehicles like 2W, 3W,4W, LCV and HCV. Flow rates are calculated and conflicting traffic flow was identified for this analysis. Based on gaps and follow-up time, the accepted and rejected number are calculated. The Rafff's Method is used to calculate critical gaps. The HCM 2010 is taken as reference manual to compute LOS, queue lengths, control delay and potential capacities based on the acquired data.

ISSN: 2057-5688

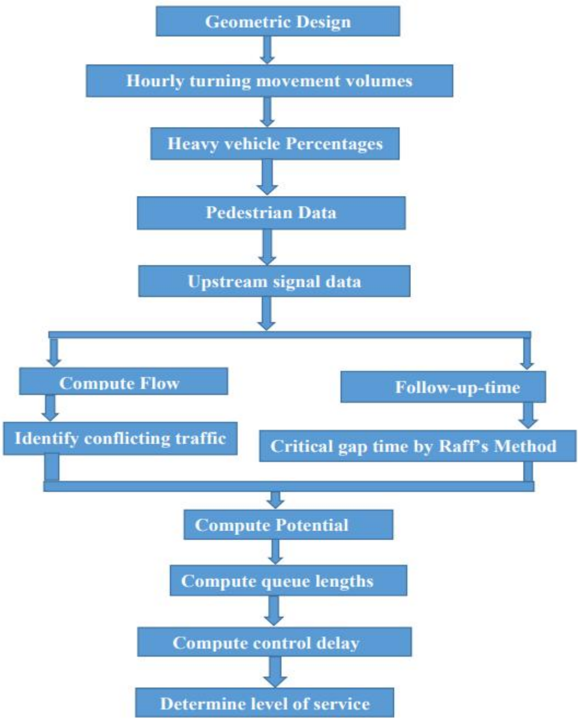

Fig.1 Flow chart of methodology

IV. OBSERVATIONS AND ANALYSIS

In this chapter the observations, analysis, results for the present study were presented. Initially, the peak hour is observed while taking traffic volumes. The total volumes and various types of vehicles through each moment are counted. It is observed that at ibrahimpatnam T Junction, the traffic is very high at 5:00 pm -6:00 pm as compared to other volumes. So 5:00 pm - 6:00 pm hour is selected as peak hour.

Geometrics and movements

The geometry of Injapur T Junction is showed in figure 4.1

Fig.2 The Site of Injapur T Junction

Introduction (Injapur T Junction)

For the present study, the names, symbols for the various movements on the road are given in the below figure. The Stop sign is indicated from Injapur minor road. All the directions like North, South, East and West are indicated for the present geometry

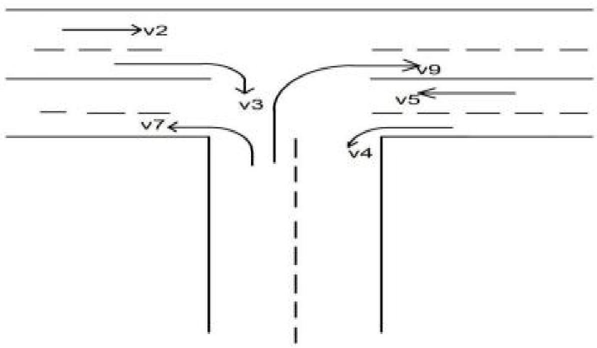

Fig.3 Geometric and flow rates at Injapour

From the video graphic survey, the total traffic volumes, the different class of vehicles like 2w, 3w, 4w, LCV and HCV Buses volumes in each direction's were recorded at this intersection. For every 15

ISSN: 2057-5688

min.The record of total traffic volumes for various class of vehicles were noted for every 15 min are shown in below tables.The peak hour traffic volumes were recorded in every 15 min. Analysis for 1 hour is shown in below tables. The various class of vehicles (2w, 4w, Bus, LCV, HCV) volumes and their percentage shares are calculated as given below.

(5:00pm-5:15pm)

INTERSECTION	Direction	2W	3W	4W	BUS	LCV	HCV	Total (Veh/hr)	Total (PCU/hr)
INJAPUR	EW(V5)	238	42	96	12	30	8	426	384.6
	WE(V2)	321	41	196	46	23	8	635	628.9
	NW(V4)	66	10	12	2	3	2	95	73.6
	NE(V3)	65	4	22	0	9	8	108	105.5
	WN(V7)	97	5	23	1	5	3	134	100.5
	EN(V9)	60	10	19	2	3	4	98	84.6
TOTAL		847	112	368	63	73	33	1496	1377.7
%SHARE		56.61	7.48	24.59	4.21	4.87	2.20	100	

Table-1 Traffic volumes & % share of vehicles in each direction for (5:00pm-5:15pm) at Injapur T-Section.

(5:15pm-5:30pm)

INTERSECTION	Direction	2W	3W	4W	BUS	LCV	HCV	Total (Veh/hr)	Total (PCU/hr)
INJAPUR	EW(V5)	276	45	155	11	20	5	512	429
	WE(V2)	355	43	234	47	40	15	734	750.9
	NW(V4)	80	8	18	1	4	1	112	80.2
	NE(V3)	81	2	32	1	3	8	127	112.2
	WN(V7)	75	12	12	0	7	5	111	92
	EN(V9)	72	10	22	0	9	2	115	92.8
TOTAL		939	120	473	60	83	36	1711	1557.1
%SHARE		54.88	7.01	27.64	3.50	4.85	2.10	100	

Table-2 Traffic volumes & % share of vehicles in each direction for (5:15pm-5:30pm) at Injapur T-Section.

(5:30pm-5:45pm)

Table-3 Traffic volumes & % share of vehicles in each direction for (5:30pm-5:45pm) at Injapur T-Section.

INTERSECTION	Direction	2W	3W	4W	BUS	LCV	HCV	Total (Veh/hr)	Total (PCU/hr)
INJAPUR	EW(V5)	259	43	99	5	24	8	438	361.2
	WE(V2)	372	41	239	26	25	4	707	617.8
	NW(V4)	67	8	13	0	3	3	94	70
	NE(V3)	75	5	16	0	9	6	111	98.3
	WN(V7)	68	11	19	1	6	9	114	110
	EN(V9)	78	4	14	0	6	4	106	83.4
TOTAL		919	112	400	32	73	34	1570	1340.7
%SHARE		58.53	7.13	25.47	2.03	4.64	2.16	100	

(5:45pm-6:00pm)

Table-4 Traffic volumes & % share of vehicles in each direction for (5:45pm-6:00pm) at

INTERSECTION	Direction	2W	3W	4W	BUS	LCV	HCV	Total (Veh/hr)	Total (PCU/hr)
INJAPUR	EW(V5)	386	40	344	10	32	8	820	702.4
	WE(V2)	263	58	150	14	25	4	514	445.9
	NW(V4)	90	12	32	0	10	4	148	122.6
	NE(V3)	65	6	25	0	6	6	108	96.5
	WN(V7)	86	12	30	0	6	10	144	130.8
	EN(V9)	72	26	20	2	4	4	128	106.6
TOTAL		962	154	601	26	83	36	1862	1604.8

The 15 min peak volumes for each direction for 1 hour is shown in below table. It is observed that the intersection occupies 6,639 vehicles per hour. Similarly1500 to 1900 vehicles were occupies for every 15 min. From the occupied volumes, the PCU's of the vehicles in each direction are calculated. The PHF values are calculated from the PCU values of the vehicles in the different directions.

ISSN: 2057-5688

Table-5 Total Traffic volume & PHF in each direction for 1 hour at Injapur T-section.

TIME INTERVAL	V5	V2	V4	V3	V7	V9	TOTAL (PCU/hr)
5:00 - 5:15	384.6	628.9	73.6	105.5	100.5	84.6	1377.7
5:15 – 5:30	429	750.9	80.2	112.2	92	92.8	1557.1
5:30 - 5:45	361.2	617.8	70	98.3	110	83.4	1340.7
5:45 - 6:00	702.4	445.9	122.6	96.5	130.8	106.6	1604.8
TOTAL	1877.2	2443.5	346.4	412.5	433.3	367.4	5880.3
PHF	0.079	0.103	0.014	0.017	0.018	0.015	----

The % of share of HCV/Trucks/Buses were calculated are shown in below table. Based on this the proportion of heavy vehicles PHV is calculated as

$$P_{HV} = \frac{1}{1+P_T(E_T-1)} -$$

Where, P_T=Proportion of trucks

Table-6 The Proportion of Heavy Vehicles

	V5		V2		V4		V3		V7		V9		Total (PCU/hr)
	HCV	BUS	HCV	BUS	HCV	BUS	HCV	BUS	HCV	BUS	HCV	BUS	
Contents	8	12	8	46	2	2	8	0	3	1	4	2	1377.7
	5	11	15	47	1	1	8	1	5	0	2	0	1557.1
	8	5	4	26	3	0	6	0	9	1	4	0	1340.7
	8	10	4	14	4	0	6	0	10	0	4	2	1604.8
Total	29	38	31	133	10	3	28	1	27	2	14	4	-
PCU (veh/h)	1877.2		2443.5		346.4		412.5		433.3		367.4		5880.3
% share of HCV	1.544		1.268		2.886		6.787		6.231		3.810		-
%Share of Buses	2.024		5.443		0.866		0.242		0.461		1.088		-
Proportion Of heavy vehicles PHV	0.1229		0.0693		0.1175		0.0664		0.0695		0.0927		-

Vehicle volume and Adjustments

INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE
ISSN: 2057-5688

Table-7 Input Data for the Analysis

Movement	V5	V2	V4	V3	V7	V9
Volume q (Veh/hr)	1877.2	2443.5	346.4	412.5	433.3	367.4
PHF=(q/4*V)	0.668	0.813	0.706	0.919	0.828	0.861
Flow Rate (q/PHF)=Veh/hr	2810	3005	490	450	523	426
Proportion of heavy vehicles, PHF	0.1229	0.0693	0.1175	0.0664	0.0695	0.0927

The input data like, total volume, PHF, flow rate, proportion of heavy vehicles for this analysis was calculated from the video graphic survey data. It is shown in above table. 4.3 Conflicting Movements The gap/lag and gap accepted and rejected data is analysed based on the two cases which is studied briefly in this project are shown below. Case 1: Minor Right Turn Conflict Point

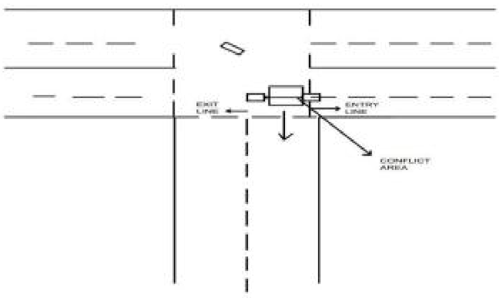

Fig.4 Conflict Point of Minor Right Turn

Major Right Turn Conflict Point

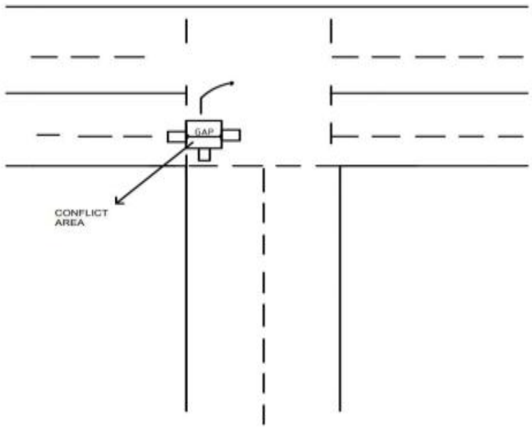

Fig.5 Conflict Point of Major Right Turn

In order to estimate critical gap and follow up time accurately in the field many researches are came up with multitude of techniques at unsignalized stop controlled and uncontrolled intersections. Some of the techniques are applied to compare briefly and to get accurate critical gap. The record of data from video graphic survey is shown in table. From the table, it was observed that the number of gaps which are accepted or rejected, gap in sec, follow-up times and clearing times etc…

ISSN: 2057-5688

The total data is produced in Appendix page.

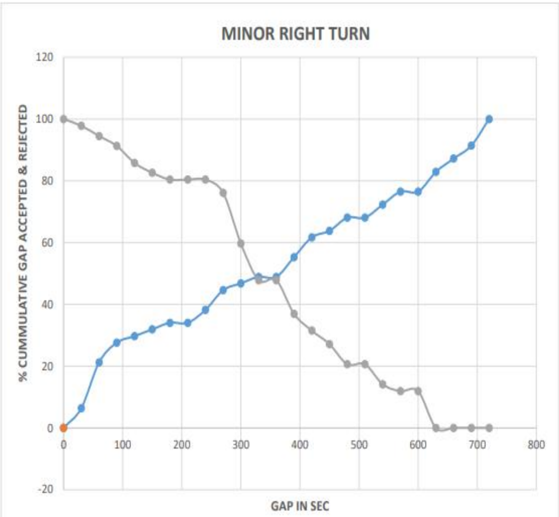

Fig.6 Critical gap from Raff's Method

V. CONCLUSION

According to the analysis of this survey, it is found that the increase in the number of vehicles on the road. The critical gap depends upon the space occupied by the type of vehicle. At the Injapur T-Intersection, the LOS is obtained as 'C' which indicates a medium flow of vehicles. To improve the level of service the signals are to be provided to minimize the conflicts for safe traffic movements. The minor road should be increased in the width of the road to increase the level of service of the road. To improve the service of the T-Intersection, the signals are needed to be installed and signs to be provided. If the increase in the width of the minor road is not possible then the alternate road should be constructed. The Level of Service (LOS) of major road is greater than the minor road.

REFERENCES

1. R.S. Drew, Traffic Flow Theroy and control, McGraw-Hill, Newyork, NY, USA, 1968.

2. N. Wu, "A universal procedure for capacity determination at unsignalized (priority controlled) intersections," Transportation Research Part B: Methodological, vol. 35, no. 6, pp. 593-623, 2001.

3. Transportation Research Board, Highway Capacity Manual, National Research Council, Washington, DC, USA, 2000.

4. R.H. Hewitt, "Measuring critical gap," Transportation Science, vol. 17, no. 1, pp,87- 109,1983.

5. A. Polus, S. S. Lazar, and M. Livneh, "Critical gap as a function of waiting time in determining roundabout capacity,"

ISSN: 2057-5688

Journal of Transportation Engineering, vol. 129, no. 5, pp. 504-509,2003.

6. R.T. Luttinen, "Capacity and level of service at Finnish unsignalized intersections," Finnra Reports, Finnish Road Administration, Helsinki, Finland, 2004.

7. R. Ashworth, "A note on the selection of gap acceptance criteria for traffic simulation studies," Transportation Research, vol. 2, no.2, pp. 171-175, 1968.

8. Transportation Research Board, Highway Capacity Manual, National Research Council, Washington, DC, USA,2000.

9. R. J. Guo and B. L. Lin, "Gap acceptance at priority-controlled intersections," Journal of Transportation Engineering, vol. 137, no. 4, pp. 269-276,2011.

10. W. Brilon, R. Koenig, and R. J. Troutbeck, "Useful estimation procedures for critical gaps," Transportation Research Part A: Policy and Practice, vol. 33, no. 3-4, pp. 161- 186,1999