Scientific Journal of Impact Factor (SJIF): 4.14
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 3, Issue 6, June -2016

Estimating Traffic Congestion on Urban Roads: A case study of "Panchvati Intersection"

Ishan Tripathi[1]

[1]*UG student, Civil Engineering Department, Gandhinagar Institute of Technology*

***Abstract** - Traffic congestion problem is one of the most emerging component in urban transportation system now a days. Estimation of traffic congestion is essential to select appropriate mitigation measures. Key elements of urban transportation systems are Signalized Intersections which carry heavy traffic movements of motorized, non-motorized vehicles and pedestrians. They generate many conflicts among crossing, turning and merging maneuvers. Because of growth of population and vehicle ownership, traffic demand increases in peak hours, which causes considerable traffic congestion. The congestion causes air pollution, noise, consumption of fuel, accidents and delay. Capacity analysis is essential for planning, designing and operation of urban transportation networks. Capacity analysis of signalized intersection is more important because such intersections control the ability to accommodate traffic. Level of Service (LOS) is a qualitative measurement of operation of roads. In Ahmedabad city, most of the signalized intersections are having traffic congestion problem and operated in LOS E and F. There is a need to define traffic congestion on rational bases to use that to determine Level of Service of roads. An attempt has been made to quantify traffic congestion on signalized intersection i.e. Panchavati Intersection of Ahmedabad city with respect to delay and volume to the capacity ratio.*

***Keywords –** Congestion, Capacity, Level of Service (LOS), Delay, Signalized Intersections*

I. INTRODUCTION

Traffic congestion is the major problem of most of the metropolis across the world. Identification of traffic congestion is first step towards the selection of appropriate mitigation measures. Signalized Intersections are key elements of Urban Transportation for the movement of traffic. In Ahmedabad city, most of the signalized intersections are congested and operated in LOS E and F. To quantify congestion, traffic volume count survey and road inventory data survey are done at "Panchvati Intersection", Ahmedabad city by using video camera. An attempt has been made to quantify congestion with delay and volume to the capacity ratio
.

1.1 **Congestion:**"Traffic congestion is a situation when traffic demand (i.e. no. of vehicles and pedestrians) exceeds the capacity of urban transportation network."

1.2 Causes of congestion at Panchvati Intersection:

- Illegal parking along the roadside
- Improper development of Surrounding Area
- Improper lane management
- Improper signal management

II. SITE DETAILS

2.1 Site Selected: Panchvati Intersection, Ahmedabad.
2.2 Site Description: It has a major intersection where 4 "arterial roads" and 1 "sub-arterial road" meets. At this intersection highly hourly traffic flow causes traffic congestion and traffic congestion causes delay.

Figure 1. Google Image of "Panchvati Intersection"

III. METHODOLOGY

3.1 Traffic Survey

Types of surveys conducted:

1) Traffic volume count survey and classified traffic volume count survey
2) Road Inventory data survey
3) Observation of effective signal timings of already existing signals at each leg of signalized intersection

3.1.1 Traffic Volume Count Survey

Traffic volume count survey is done by putting video camera on nearby building from where intersection along with traffic and moving vehicles is seen. And then traffic volume count and classified traffic volume count is determined by video analysis.

Table 1. Traffic Volume Count Survey

Sr No	Name of Road	Turning maneuvers			Total (PCU/hr)
		Left (PCU/hr)	Straight (PCU/hr)	Right (PCU/hr)	
1	C.G.Road	128	454	447	1029
2	Law Garden	208	1187	354	1749
3	Parimal Garden	156	880	377	1413
4	Ambawadi	368	1088	235	1691
5	GulbaiTekra	199	435	161	795

3.1.2Road Inventory Data Survey:

Table 2. Road Inventory Data Survey

		C.G Road	Law Garden	Parimal Garden	Ambawadi	GulbaiTekra
Footpath Width	***LHS***	1.4	0.5	1.55	1.42	1.5
	RHS	2.5	0.5	1.44	1.42	1.6
Carriageway Width	***LHS***	9.41	12.74	10.25	10.4	8.45
	RHS	7.1	12.54	10.44	9.5	7.8
Median Width	***LHS/RHS***	0.75	0.5	0.73	0.7	0.72
Street Light	***LHS/RHS***	Yes	Yes	Yes	Yes	Yes
Traffic signal	***LHS/RHS***	Yes	Yes	Yes	Yes	Yes
Bus Stand	***LHS***	Yes	Yes	No	No	No
	RHS	No	No	No	No	No
Parking	***LHS***	Yes	No	No	No	No
	RHS	Yes	No	No	No	No

3.1.3 Determination of effective signal timings:

Effective Signal timings are determined by observing effective red time, green time and total cycle time at each road where there is already existing signal.

Table 3. Effective Signal Timings of Already Existing Signal

Panchvati Intersection	C.G Road	Law Garden	Parimal Garden	Ambawadi	GulbaiTekra
Effective Red Time	177 sec	177 sec	177 sec	130 sec	177 sec
Effective Green Time	40 sec	35 sec	40 sec	45 sec	30 sec
Total Cycle Time	220 sec	215 sec	220 sec	178 sec	210 sec

3.2 Passenger Car Units

In developing countries like India, There is heterogeneous traffic condition. The problem of measuring volume of heterogeneous traffic condition can be overcome by converting the different types of vehicles into equivalent Passenger Cars and measuring volume in terms of Passenger Car Units (PCU) per hour. PCU is derived by considering Passenger Car as a standard vehicle.

Table 4. Proposed PCU Equivalents in the Draft Revision of IRC Guidelines for capacity

Vehicle Type	PCU(single lane and two lane roads)	PCU(multi-lane roads)
Passenger car	1.0	1.0
Bus or Truck	4.0	4.5
Multi-Axle Truck	5.0	6.0
Light Commercial Vehicle	2.5	2.8
Tractor	3.0	3.0
Tractor-Trailer	4.5	4.5
3-Wheeler	1.4	1.6
Motorized Two Wheeler	0.4	0.5
Pedal Cycle	0.6	0.6
Pedal Rickshaw	2.0	2.5
Horse cart	4.0	4.0
Bullock cart	7.0	7.0

3.3Saturation Flow

S=525*w PCU/hour

Where, s = saturation flow

w = width of approach road in meters measured kerb to inside of pedestrian refuge or center line whichever is nearer or to the inside of the central reserve in case of a dual carriageway

3.4 Effective Green Ratio

$$\textbf{Effective Green Ratio (g/C)} = \frac{Effective\ green\ time}{Total\ Cycle\ time}$$

Where, g = effective green time

C = total cycle time

3.5 Capacity

Capacity as defined by HCM: "The maximum hourly rate at which persons or vehicles can be reasonably expectedto traverse a point or uniform segment of a lane or roadway during a given time periodunder prevailing conditions."

3.5.1 Capacity of signalized Intersections

Capacityat signalized intersection is based on the concept of saturation flow and saturation flow rate. The flow ratio for a given lane group is defined as the ratio of the actual or projected demand flow rate for the lane group (vi) and the saturation flow rate (si).

The capacity of a given lane group is stated as shown in equation

ci= si (g/C) ……….. (*Equation 16-6 HCM, 2000)*

Where, ci= Capacity of lane group I (veh/hr),

si= Saturation flow rate for lane group I (Veh/hr)

g/C=Effective green ratio for lane group.

v/c ratio:

v/c ratio, often called as volume to capacity ratio, is given symbol X in intersection analysis. It is typically referred to as degree of saturation.

For a given lane group I, X is computed using the equation.

X= (v/c)i……….. (*Equation 16-7 HCM, 2000)*

Where, X =(v/c) ratio for lane group,

vi =Actual flow rate for the lane group i(veh/hr)

si =Saturation flow rate for lane group i(veh/hr)

3.6 Delay

Webster (1958) developed a model for estimating the delay incurred by motorists at under saturated signalized intersections that became the basis for all subsequent delay models. The model developed is presented in Equation given as below,

$$\mathbf{d} = \frac{C\,(1-\lambda)^2}{2(1-\lambda X)} + \frac{x^2}{2v(1-X)} - 0.65\left(\frac{C}{v^2}\right)^{1/3}\left[X^{2+5\lambda}\right]$$

Where:

d = average overall delay per vehicle (seconds),

X= v/c ratio,

λ = proportion of the cycle that is effective green (*g/C*),

C = cycle length (seconds),

v = arrival rate (vehicles/hour),

c = capacity for lane group (vehicles/hour),

g = effective green time (seconds).

3.7 Level of Service (LOS)

Level of service is qualitative measurement of operation of roads. Six levels of service are recognized commonly from A to F. A refers to the best operating condition and Level of Service F is worst.

Table 5. LOS criteria based on delay

LOS	Signalized Intersection (sec/veh)	Non-signalized Intersection(sec/veh)
A	<=10	<=10
B	10-20	10-15
C	20-35	15-25
D	35-55	25-35
E	55-80	35-50
F	>80	>50

Table 6. Highway Capacity Manual's description of the six LOS's for a signalizedintersection

LOS	Average delay per vehicle
A	Very low control delay 10 or less seconds per vehicle; progression is very favorable; most vehicles arrive during green signal; most vehicles do not stop. Short cycle lengths may also contribute to low delay.
B	Control delay greater than 10 and up to 20 seconds per vehicle; progression is good and /or cycle lengths are short. More vehicles stop than for LOS A, causing higher levels of average delay.
C	Control delay greater than 20 and up to 35 seconds per vehicle; progression is fair and/or cycle lengths are longer. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant, though many vehicles still pass through without stopping.
D	Control delay greater than 35 and up to 55 seconds per vehicle; progression is unfavorable, cycle lengths are long, or has a high flow rate to capacity ratio. Many vehicles stop, and the proportion of vehicles not stopping diminishes. Individual cycle failures are obvious.
-E	Control delay greater than 55 and up to 80 seconds per vehicle; progression is poor, cycle lengths are long, and has a high flow rate to capacity ratio. Individual cycle failures are frequent occurrences.
F	Control delay greater than 80 seconds per vehicle; progression is very poor, cycle lengths are long. Many individual cycle failures. Arrival flow rates exceed the capacity of the intersection. This level is considered unacceptable to most drivers.

IV. CALCULATIONS AND RESULTS

Sr No	***Road Name***	***Carriageway width (in m)***	***Saturation flow Sr=525*w (PCU/hr)***	***Effective green ratio (g/c)***	***Capacity (PCU/hr)***	***Volume (PCU/hr)***	***x=(v/c) (v/c) ratio***	***Delay (sec/PCU)***	***LOS Based on Delay***
1	C.G.Road	9.41	4941	0.18	890	1029	1.15	94.49	F
2	Law Garden	12.74	6689	0.16	1071	1749	1.63	102.5	F
3	Parimal Garden	10.4	5460	0.18	983	1413	1.43	99.75	F
4	Ambawadi	10.25	5382	0.25	1346	1691	1.25	72.75	E
5	GulbaiTekra	8.45	4437	0.14	622	795	1.27	94.61	F

V. CONCLUSIONS

- On all the roads, volume exceeds capacity so v/c ratio is greater than 1which indicates situation of congestion and LOS (Level of Service) F
- Effective green ratio is very less on each road so vehicles get less time to pass through intersection
- LOS of C.G.Road , Law Garden , Parimal Garden and GulbaiTekra roadsis 'F' based on delay, which indicates poor progression , long cycle length and slowarrival rates. This condition is not acceptable for most of the drivers
- LOS of Ambawadi is 'E', which shows high flow rate to capacity ratioand poor progression of vehicles
- Efficient signal design and optimization is considered as mitigation measure of congestion at "Panchvati Intersection"

REFERENCES

[1] Mr. Udit Batra, Mr. Mandar V. Sarode, "Traffic Surveying and Analysis", International Journal of Application or Innovation in Engineering and Management, ISSN 2319-4847

[2] Amudapurum Mohan Rao, Kalga Ramchandra Rao, "Measuring Urban Traffic Congestion- A Review", International Journal of Traffic and Transportation Engineering, 2012, 2(4):286-305

[3] Mira Patel, "Solution for reduction of traffic congestion:A case study of thaltej rotary intersection", Internatonal Journal of Applied Engineering and Technology, ISSN:2277-212X, 2014 Vol.4, January-March, pp. 37-45

[4] Indian Road Congress IRC:106-1990, "Guidelines for capacity of urban roads in plain areas"

[5] Transporation Research Board, United States, HCM:2000, "LOS Interpretations"

[6] Dr. S.K.Khanna, Dr. C.E.G. Justo, Dr. A. Veeraragavan, "Highway Enginnering", 10th edition, ISBN 978-81-85240-72-5

[7] Dr. L.R. Kadiyali, "Traffic Engineering and Transport Planning", ISBN No. 81-7409-220-X

