Traffic Signal and Junction Design: A Case Study of Rajkot City

Vaishali Parmar
Department of civil engineering, Indus University Ahmedabad, India

Ruchika Lalit
Department of civil engineering, Indus University Ahmedabad, India

***Abstract*—The increase in development and, hence traffic hindering create a critical need to operate our transportation systems with maximum capability. Real time traffic signal control is a main part of new part of the new urban traffic control systems aimed at achieving the best utilization of the road network. The use of traffic signal for control of different streams of vehicular and pedestrian traffic is wide in most of the towns and city. This study focused on the junction of the Rajkot city which is located in the saurashtra region of Gujarat state. A classified volume count survey had been carried out to monitor the traffic and the collected data was utilized for the design of traffic signals using Webster's formula. Based on the analytical part, author suggested an auxiliary lane design as per IRC 41-1994.**

***Keywords*— Traffic Signal, Auxiliary Lane, Traffic Management, Traffic Volume,**

I. INTRODUCTION

Traffic signals are the means of retaining a resolute flow of traffic in an suitable way and to reduce the conflicts at junctions as well as roads. They provide more efficiency if designed properly. The first traffic signal is stated to have been used in London as early as in 1868 and was of the semaphore -arm type with red and green lamps for night use. During the 100 years since then traffic signals have been original to a high grade of difficulty. Providing effective real time traffic signal control for a large hard traffic for a network is a very inspiring circulated control difficult. Signal system process is further more hard by the new advance that views the traffic signal system as a small part of a combined multimodal transportation system.

The urban traffic system is a very difficult system which involves many relationships among them is more complex. The setup the system for an area with the traffic needs to be calculated and before setting it up. This helps in the calculation and the efficiency of the flow through the area and types out the correction that can be applied to growth the traffic flow.

II. AIM AND OBJECTIVES

Aim of this study is to prepare a plan for traffic signal by study of junction design. In particular, in this work we show that i) the geometric and signal setting features of typical traffic signal. ii) Traffic flow pattern through the signal. iii) Estimate the performance of a signal iv) and suggest the remedial measures to improve the performance of the traffic signal.

III. GENERAL BACKGROUND

A. Signals in India

According to Indian Practice, an amber period of 2 seconds as an change intermission between finish of related green drive and display of red signal or between finish of a red signal and origination of related green movement.

B. Pedestrian Signal

According to IRC:093 the Traffic Signals suggests the following symbols for foot-travelers. The red standing man signifies that don't cross signal and the green walking man represents cross signal. A flashing amber signal is a danger sympathy beacons normally used to warn of blockade and joints to increase regularity signs and to warn of midblock cross - walks

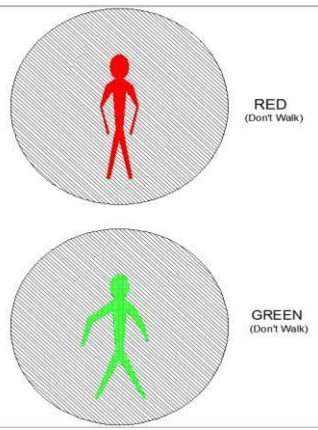

Fig1: Pedestrian Signal Indications as per Indian practice

C. Signal Face

- The minimum number of lenses in a signal face is three - red, amber and green. The lenses in a signal face can be prepared in a vertical or horizontal straight line. The relative points are red, amber and green. A simple signal face with three lenses in a vertical line is indicated in the Fig2.
- The lenses are normally of two sizes, viz., 200mm and 300 mm diameter. The larger size is used where the 85^{th} percentile line speeds exceeds 65 K.P.H For problematic area, for all arrow signal, for Caution where signalization may be unforeseen and for conflicts where drivers may view both traffic control and lane directions control signs simultaneously.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 07, July - 2017

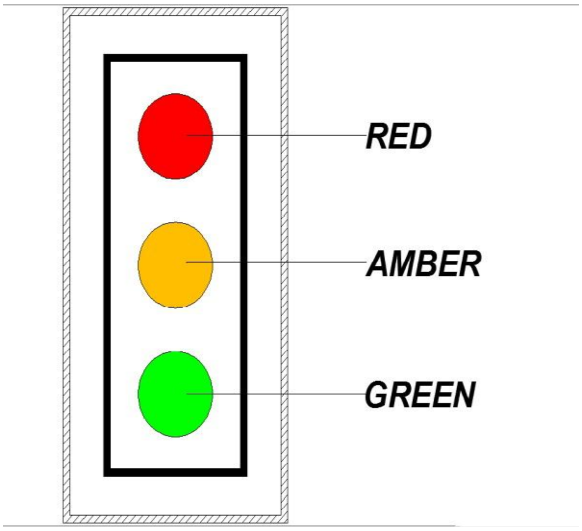

Fig2: Signal Face

- Do not mix complete spellings and abbreviations of units: “Wb/m2” or “webers per square meter,” not “webers/m2.” Spell units when they appear in text: “...a few henries,” not “...a few H.”
- Use a zero before decimal points: “0.25,” not “.25.” Use “cm3,” not “cc.” (*bullet list*)

D. Traffic Cycle time in Indian practice

In Indian practice, a typical example of signal indications in a three phase signal is red, green and amber. The amber interval is change interval between end of related green movement and starting of a red signal or between finish of a red signal and origination of related green movement. . In the first case it is “Permission Amber” and in the second case it is called “Initial Amber". The amber period is generally 2 seconds.

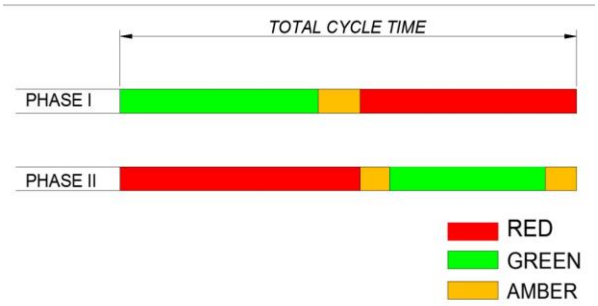

Fig3: Signal indications in a two phase signal

IV. CASE STUDY OF RAJKOT CITY

Rajkot is the fourth-largest city in the state of Gujarat, India, after Ahmedabad, Surat and Vadodara. Rajkot is the centre of the Saurashtra region of Gujarat. Rajkot is having approximately 1.2 millions of population as of 2015 and metropolitan area is 170km^2

Identify applicable sponsor/s here. If no sponsors, delete this text box (*sponsors).*

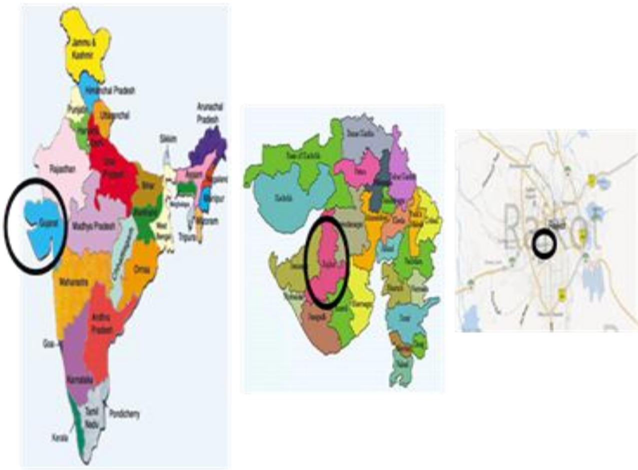

Fig4: Location of Rajkot city

A. Methodology

To install the traffic signal and for the geometric design of junction we have to conduct out several types of surveys:

1. Classified volume count survey
2. Road side interview survey
3. Public and Para-Transit Transportation survey
4. Origin and Destination survey
5. Home interview survey
6. Registration plate number survey
7. Parking survey
8. Pedestrian survey

- Main purposes of traffic survey:

The main purposes of traffic survey are traffic monitoring, traffic control and management, traffic enforcement, traffic forecasting, model calibration and validating etc.

In this research work, we had perform classifeid volume count survey there are two major methods of counting vehicle for volume survey

a) Manual Counting Method

b) Automatic counting method.

From the above two methods we had conducted manual volume counting method.

- Importance of Traffic Volume Study:

a) Increase the efficiency and life of roads
b) Reduces traffic volume at a particular section
c) Provide better means for development of infrastructures
d) Provide better means to utilize other roads in case of special events in the city
e) Provide estimate of no vehicles against no of persons Methodology

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 07, July - 2017

B. Location of volume count survey

Fig5: Location Map

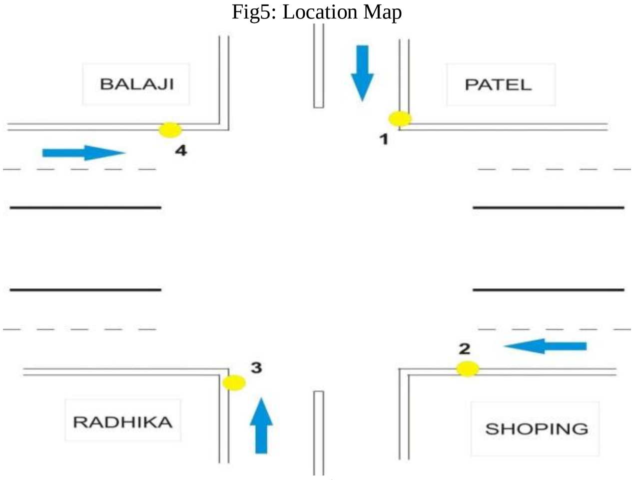

Fig 6: Location of Mavdi chowk

C. Data Collection and Result Analysis

As we had collected the volume count survey data during morning peak hour and evening peak hour. The data collected during the survey is represented from the following table:

Sl No	Time Period		LCV				HCV			NMT		Others	Total
	From	To	Two Wheeler	Auto Rick-shaw	Car/ Jeep	Tempo	Bus	Truck	Tractor	Bicycle	Animal Drawn Cart		
			0.5	1.2	1	1.4	2.2	2.2	4	0.4	1.5	2	
1	8:00	8:1	298	18	68	5	8	2	2	4	0	2	281
2	8:15	8:3	300	20	70	3	6	4	2	6	0	1	265
3	8:30	8:4	309	16	74	7	3	4	1	3	0	2	281
4	8:45	9:0	319	23	69	6	3	3	3	5	0	5	282
5	9:00	9:1	329	24	71	5	2	2	5	9	0	8	282
6	9:15	9:3	341	28	79	10	6	7	6	7	0	6	301
7	9:30	9:4	352	29	80	12	5	6	5	10	0	7	319
8	9:45	10:	378	24	86	12	3	3	2	7	0	3	364
9	10:0	10:	380	30	71	9	2	2	1	3	0	1	369
10	10:1	10:	388	31	67	10	2	4	1	5	0	2	350
11	10:3	10:	365	29	62	4	3	3	1	7	0	0	325
12	10:4	11:	342	30	59	2	1	3	2	3	0	2	344

Table1. Morning peak hour data

PCU (Passenger Car Unit)

Morning peak hour data

PCU = Volume/Capacity
PCU = 3531.14/3600
PCU = 0.98087

Sl No	Time Period		LCV				HCV			NMT		Others	Total
	From	To	Two Wheeler	Auto Rick-shaw	Car/ Jeep	Tempo	Bus	Truck	Tractor	Bicycle	Animal Drawn Cart		
			0	1		1	2	2		0	1	2	
1	8:0	8:1	2	22	3	4	1	2	1	1	0	0	233
2	8:1	8:3	3	21	4	3	2	1	1	9	0	1	213.2
3	8:3	8:4	3	29	4	4	5	2	2	4	1	0	233
4	8:4	9:0	3	27	5	5	3	3	1	1	0	1	242.6
5	9:0	9:1	3	30	5	8	1	2	1	4	0	2	271.9
6	9:1	9:3	3	34	5	1	2	1	2	5	0	3	278.5
7	9:3	9:4	399	32	60	9	1	0	1	7	0	1	303.4
8	9:4	10:	409	33	68	8	1	0	1	14	0	1	3250
9	10:	10:	4	24	7	7	6	2	1	4	0	1	321.5
10	10:	10:	4	20	7	7	3	2	1	8	1	2	337.1
11	10:	10:	4	19	7	6	4	0	0	1	0	1	345.3
12	10:	11:	4	24	8	5	2	1	0	4	0	0	353

Table2. Evening peak hour data

Evening peak hour data

PCU = Volume/Capacity
PCU = 3457.90/3600
PCU = 0.960

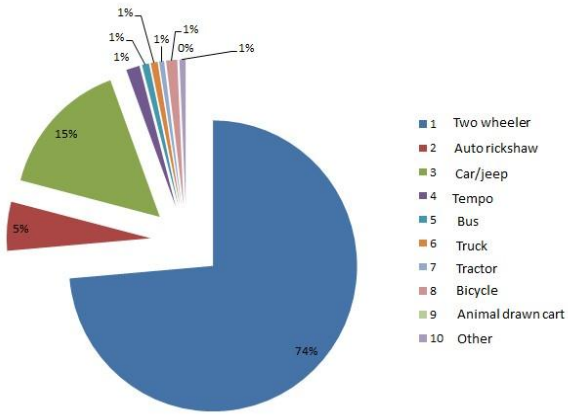

Fig 7: Traffic composition during morning peak hour

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 07, July - 2017

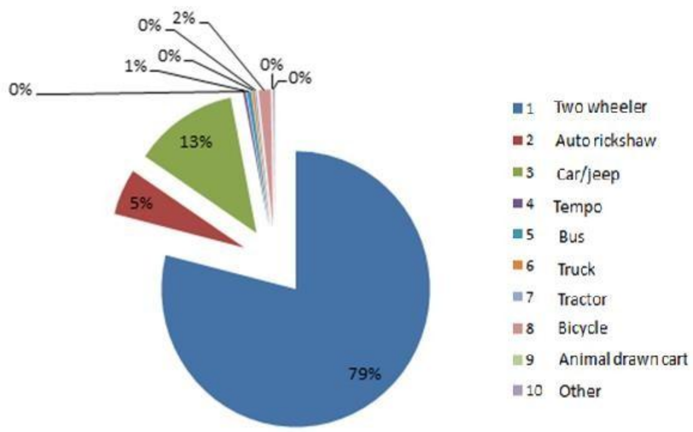

Fig 8: Traffic composition during Evening peak hour

Design of signal Timing

1. For Morning Peak data

From equation Webster's formula we have,
Optimum cycle length in seconds

L = Total lost per cycle

= 6 seconds (lost time per cycle)

y = Flow / Saturation flow of an approach
s = 650 w PCU/ per hour
Therefore,

- For phase I

s = 650 X 6 = 3900 PCU/per hour

- For Phase II,

The width of the road occupied by the vehicle is considered to be 5 m whose saturation value is provided accordingly to equation and hence the saturation value has to be increased as per observation by 650.

s = (1890 X 650)/525 = 8190 PCU/per hour

- For phase III,

Therefore,
s= [(1890 X 650)/525] X 3 = 8190 PCU/per hour

Now,

Y = y1+y2+y3............... (Since it's a three phase signal) where, y is the ratio of actual flow to saturation flow.

i.e., Y = Volume/Saturation flow for critical approach in each phase
y= q/s

- For Phase I,
  y1 = 1696/3900
  = 0.43

- For Phase II,
  y2= 1969/8190
  = 0.24

- For Phase III,
  y3= 1927/8190
  = 0.23

Therefore,

Y = 0.43+0.24+0.23

Y = 0.90

From equation

$$C_o = \frac{(1.5\ X6\ )L + 5}{1 - 0.90}\ \text{seconds}$$

$C_o =$ 140 seconds

Therefore, the total effective green time can be given as

$$C_o = (C_o - L)\ \text{seconds}$$

= 140-60
= 130 seconds

Effective green time for each phase,

Where

g= (y1/Y) X total effective green

- For Phase I,
  g1= (0.43/0.90) X 134
  = 64.02 seconds

- For Phase II,
  g2= (0.24/0.90) X 134
  = 42.72 seconds

- For Phase III,
  g3= (0.23/0.90) X 134
  = 34.24 seconds

However, provide a minimum green time of 15 seconds. Therefore taking g3 as 34.24 seconds. The total cycle time by providing 3 seconds for amber is found to be 143 seconds

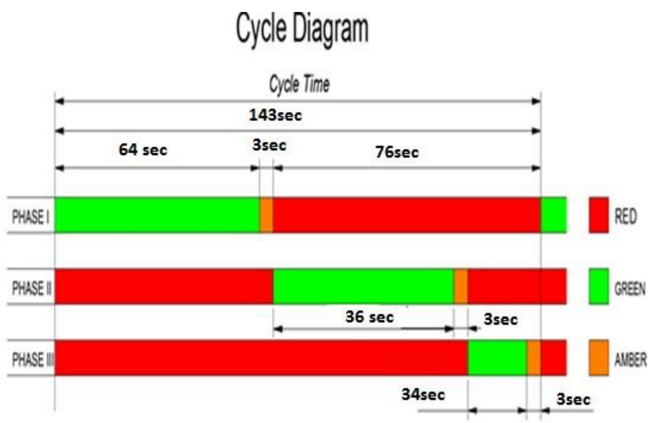

Fig 9: Timing Diagram (Morning Peak)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 07, July - 2017

2. For Evening Peak data

From equation

$$C_o = \frac{1.5\,L + 5}{1 - Y} \text{ seconds}$$

We have, L = 6 seconds (lost time per cycle)

Considering the saturation to be high,
Taking, s = 650 w PCU/ per hour

Therefore,

- For phase I,
  s = 650 X 6 = 3900 PCU/per hour

- For Phase II,

The width of the road occupied by the vehicle is considered to be 5 m whose saturation value is provided accordingly to equation and hence the saturation value has to be increased as per observation by 650.

s= [(1890 X 650)/525] X 3 = 8190 PCU/per hour

- For phase III,

Therefore,

s= [(1890 X 650)/525] X 3 = 8190 PCU/per hour

Now,
Y = y1+y2+y3............... (Since it's a three phase signal) where, y is the ratio of actual flow to saturation flow. i.e

y= q/s

- For Phase I,
  y1 = 1608/3900
  = 0.41

- For Phase II,
  y2= 2010/8190
  = 0.24

- For Phase III,
  y3= 2238/8190
  = 0.27

Therefore,

Y = 0.41+0.24+0.27

Y = 0.92

From equation

$$C_o = \frac{(1.5\,X6\,)L + 5}{1 - 0.90} \text{ seconds}$$

C_0 = 175 seconds

Therefore, the total effective green time can be given as

$$C_o = (C_o - L) \text{ seconds}$$

= 175- 6
= 169 seconds

Effective green time for each phase,

Where

g= (y1/Y) X total effective green

- For Phase I,
  g1= (0.41/0.92) X 169
  = 75.13 seconds

- For Phase II,
  g2= (0.24/0.92) X 169
  = 44 seconds

- For Phase III,
  g3= (0.27/0.92) X 169
  = 49.59 seconds

However, provide a minimum green time of 15 seconds. Thus taking g3 as 49.59 seconds. The total cycle time by providing 3 seconds for amber is found to be 178 seconds.

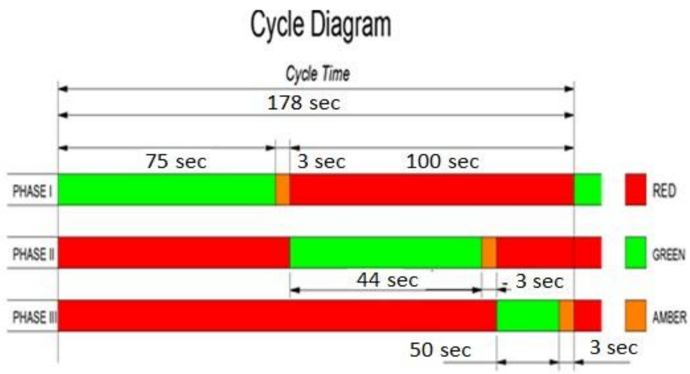

Fig 10: Timing Diagram (Evening Peak)

V. Solution

1. Provide proper timing cycle to peak hour morning and evening time
2. Provide Auxiliary Lanes at road to reduce traffic congestion

   - As per IRC 41-1994, Intersection operation can be increased by including auxiliary lanes for right turn (fig1), or left turn (fig2) or through lanes.
   - When turning speeds are more than 25 km ph., the lane generally separated by an island, which also serves as pedestrian refugee
   - Right turn lane is provided by recessing the median.
   - The length of the lane usually varies from 30 to 90 m, depending upon flow.

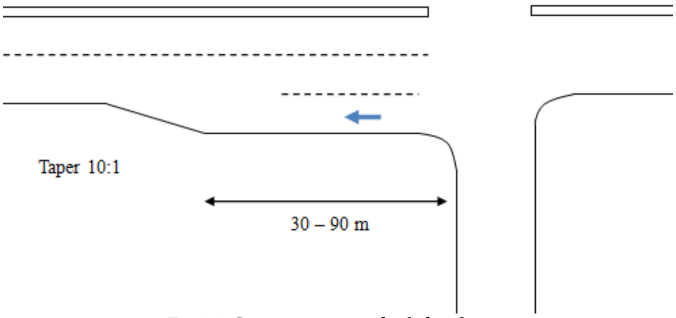

Fig 11: Suggestion view for left side

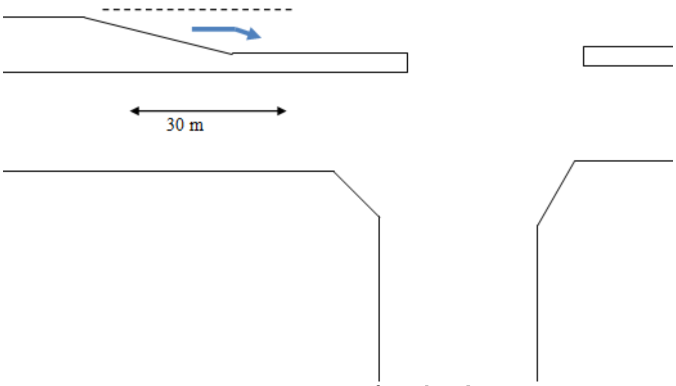

Fig 12: Suggestion view for right side

VI. CONCLUSION

On the basis of comparative studies of the traffic signal and junction design, we have conclude that an auxiliary on junction with slope of 10:1 at the intersection of road width two auxiliary lane are provide to reduce traffic congestion problem. A great care should be taken to design junction at inter section for pedestrian and bicycle track .with the study of traffic volume count survey it is given in IRC that if traffic volume less than 5000 so we have to give rotary or round about, but in our study traffic volume count is more than 5000, so we conclude suggest Auxiliary lane on both side of the road.

ACKNOWLEDGMENT

We would like to take this opportunity to express our profound gratitude and deep regard to the final year B.Tech students of RK University, Rajkot for their exemplary work, valuable feedback and constant encouragement throughout the duration of the project.

VII. REFERENCES

[1] Dr. Santosh Ajalihal, Dr. T.S. Reddy, Kayitha Ravinder. Proceedings of eastern asia society for transportation studies vol 5 (2005): 1009-1024.
[2] Ibrahim, Johnnie Ben-Edige and Iffazun Mohd. University Technology Malaysia (January 2010): ISSN 1819-6608 vol 5 no.1 .
[3] Justo, S.K Khanna and. Highway Engineering. New Delhi: Khanna publication, n.d.
[4] Kadiyali, L.R. Traffic Engineering and Transport Planning. New Delhi: Khanna publications, n.d.