International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2014): 5.611

ISKON Rotary Intersection on S.G Highway in Ahmedabad as Signalized Intersection - A Case Study

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Abstract: ***ISKON Rotary Intersection on S.G highway in Ahmedabad is a four-legged rotary intersection and has potentially failed as flow is much higher than the capacity of rotary. Rotary is oversaturated and the LOS is F. Intersection performance is evaluated if it is converted to signalized intersection. Traffic flow coming from sharkhej, Gandhinagar, Bopal and Satellite road was recorded for the intersection. Traffic consists of car, auto-rickshaw, bus, two wheelers and bicycle. Data for Lane Group, Approach volume, Intersection volume at ISKON intersection is collected. ISKON intersection volume is 6107 veh/hr. Maximum approach volumes are on north approach i.e. from Theltej side which is 1770 veh/hr. It is 29% of total intersection volume. Minimum approach volume is on west side i.e. from Bopal side which is 1419 veh / hr. It is 23% of total intersection volume. A four phase signal system is selected for the intersection. Amber time, Pedestrian crossing time Optimal cycle length and Delay is Determined. Even if ISKON rotary intersection is converted to signalized intersection, LOS is E and D which is not very much desired. So conversion of ISKON rotary intersection to signalized intersection is not justified.***

Keywords: Rotary Intersection, signalized intersection, Level of service, Optimum cycle length

1. Introduction

For more than three decades modern roundabouts have been used successfully throughout the world as a junction control device. Evaluation of junction capacity is very important since it is directly related to delay, level of service, accident, operation cost, and environmental issues. Ahmedabad also has its share of roundabouts. There are three legs; four legs; five legs and six legs roundabouts in Ahmedabad.

It is seen that Iskon Rotary Intersection on S.G highway in Ahmedabad has potentially failed as flow is much higher than the capacity of rotary. Rotary is oversaturated and the LOS provided is F. Here we will evaluate the intersection performance if it is converted to signalized intersection.

ISKON Intersection: This is four-legged rotary intersection. During peak hours (morning peak), the intersection gets over saturated (Demand more than capacity). The road surface condition at study approaches is good, affecting the speed of vehicles. Traffic flow was recorded for the intersection, coming from sherkhej, Gandhinagar, Bopal and Satellite road. Traffic consists of car, auto-rickshaw, bus, two wheelers and bicycle.

Table 1 shows the Lane Group, Approach volume, Intersection volume at ISKON intersection.

Detailed collected data at ISKON intersection are shown separately. It shows ISKON intersection volume is 6107 veh/hr. Maximum approach volumes at ISKON intersection is on north approach i.e. from Theltej side which is 1770 veh/hr. It is 29% of total intersection volume. Minimum approach volume is on west side i.e from Bopal side which is 1419 veh / hr. It is 23% of total intersection volume.

Table 1: Lane Group, Approach volume, Intersection volume at ISKON intersection

Name of intersection: ISKON Intersection					
Peak survey Time: 9.00 A.M - 11.00 A.M					
Sr. No.	*Approach*	*Lane Group*	*Lane Group volume (veh/h)*	*Approach volume (veh/h)*	*Intersection volume (veh/h)*
1.	NORTH	Left turn	175	1770	6107
2.		Through	1105		
3.		Right turn	490		
4.	SOUTH	Left turn	141	1423	
5.		Through	995		
6.		Right turn	287		
7.	EAST	Left turn	183	1495	
8.		Through	916		
9.		Right turn	396		
10.	WEST	Left turn	144	1419	
11.		Through	991		
12		Right turn	284		

Source: Traffic survey

Design of Signalized Intersection

A four phase signal system is selected for the intersection. The geometric parameter of the intersection is as mentioned in table 2

Table 2: Geometric details for Case study Intersection

Name of intersection: ISKON Intersection					
Approach	Lane Group	No. of lanes Per lane Group	Width per lane (m)	Approach Width (m)	Approach Grade (%)
North	Left turn	1	3	28	0
	Through	2	3		
	Right turn	1	3		
South	Left turn	1	3	28	0
	Through	2	3		
	Right turn	1	3		
East	Left turn	1	3	26	0
	Through	2	3		
	Right turn	1	3		
West	Left turn	1	2.5	18	0
	Through	1	2.5		
	Right turn	1	2.5		

Source: Traffic survey

Approach width = one direction lane group width + median width + another direction flow lane group width

Approach width (North) = 12+ 4 + 12 = 28
Approach width (South) = 12+ 4 + 12 = 28
Approach width (East) = 12 + 2 + 12 = 26
Approach width (West) = 7.5 + 3 + 7.5 = 18
Phase I- North – South through
Phase II- North –South right turn
Phase III- East-west through
Phase IV- East-west right turn

Determination of Amber Time

Amber time is determined using the dilemma zone analysis. The amber time for phase I and III is determined using equation

$$\tau \min = tr + \frac{v}{2}d + \frac{w+L}{v} \qquad (1)$$

Where tr = perception reaction time
V= design speed=45Kmph = 12.5 m/s
d= comfortable deceleration rate = 4m/s
w = width of intersection which the vehicle of length L can cross during amber time
L = Length of vehicle.
thus ta(I)=5secs
ta(III)=5secs

Determination of Pedestrian Crossing Time

The IRC: 93-1985 suggests the use of the following equation for determining tp, the time to be allotted for pedestrian crossing.

$$tp = 7 + \frac{w}{1.2} \qquad (2)$$

Where w is the width of road in m which the pedestrians have to cross and tp is the crossing time in seconds.

Thus tp(I) = 29 s.

tp (III) = 30 s.

Determination of Optimal Cycle Length

In order to obtain optimal cycle length Co, first the saturation flows is calculated and then the critical flow ratios are obtained. The saturation flows are calculated as per IRC 93-1985

Table 4: Determination of saturation flow

Approach	*Width (m)*	*Saturation flow in PCU/ (h of green)*
Eastbound through and left-turn approaches	3*3=9	525*9 = 4725
Eastbound Right-turn approaches	3	1850
Westbound through and left-turn approaches	3*2 = 6	525* 6 = 3150
Westbound Right-turn approaches	3	1850
Northbound through and left-turn approaches	3*3=9	525*9 = 4725
Northbound Right-turn approaches	3	1850
Southbound through and left-turn approaches	3*3=9	525*9 = 4725
Southbound Right-turn approaches	3	1850

Based on the above saturation flows and the phasing scheme, the critical flow ratios are calculated as follows:

Table 5: Determination of critical flow ratios

Phase	*Flow ratios*	*Critical flow ratios*
I	1281/4725 =0.27, 1137/4725 =0.24	0.27
II	490/1850 = 0.26, 287/1850 = 0.16	0.26
III	1099/4725 = 0.23, 1136/4725 = 0.24	0.24
IV	396/1850 = 0.21, 284/1850 = 0.15	0.21
	Total	0.98

The total time lost,

$$L = \sum ls^i + lm^i + lr^i \quad (3)$$

Or, L= 18s.

Hence Optimal cycle time as given by Webster

$$co = \frac{1.5L + 5}{1 - \sum_{i=1}^{p} (v/s)_{cr}^i} \quad (4)$$

Thus first estimate of Co =160 secs.

The final step is to determine the phase lengths and check for their adequacy with regard to pedestrian crossing times(if green time plus amber time plus all red time for a phase is greater than or equal to the pedestrian crossing time required for that particular phase, then the green time for that phase is adequate.

The total green time (without the amber time) available for distribution among the four phases is

= 160- 4* 5 = 140 secs

Green time = critical flow ratio / ∑ critical flow ratio

Table 6: Determination of Green time

Phase	*Green(s)*	*Amber(s)*	*tp*	*Is green adequate from tp consideration*
I	39	5	29	Yes (39+5 =44 >29)
II	37	5	0	Yes
III	34	5	30	Yes
IV	30	5	0	Yes

Final Signal timings for the intersection are as follows:

Cycle Length = 167 Secs.
Phase I, Green time – 40 Secs.
Amber time- 5 Secs.
Phase II, Green time – 39 Secs.
Amber time- 5 Secs
Phase III, Green time – 36 Secs.
Amber time- 5 Secs
Phase IV, Green time – 32 Secs.
Amber time- 5 Secs
There is no all red time.

Delay analysis of signalized intersection

Delay analysis is done as per Webster Equation

$$D = 0.9\left[\frac{c(1-\lambda)^2}{2(1-\lambda x)} + \frac{(x)^2}{2q(1-x)}\right] \quad (5)$$

Where , λ= g/c
q= flow/ (1.1125 * 3600) veh/sec
x= q/ λ.S
S= Saturation/3600 PCU/sec
Delay (North) = 67.28 sec.
Delay (South) = 52.36 Sec.
Delay (East) = 59.14 Sec.
Delay (West) = 61.94 Sec

Table 7: Comparison between delay and LOS

Approach	*Delay*	*LOS*
North	67.28 sec	E
South	52.36 Sec.	D
East	59.14 Sec.	E
West	61.94 Sec	E

2. Summary

From the above analysis we can see that even the ISKON rotary intersection is converted to signalized intersection, LOS is E and D which is not very much desired. So conversion of ISKON rotary intersection to signalized intersection is not justified. The better option is to convert the rotary intersection to Grade separated intersection.

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