© 2016 IJEDR | Volume 4, Issue 3 | ISSN: 2321-9939

An Evaluation of Rotary Intersection: A Case Study of Prabhat Square Raisen Road Bhopal

[1]Rakesh Kumar Chhalotre [2]Dr. Y. P. Joshi
[1]M.E. Student, [2]Professor
[1,2]Department of Civil Engineering
[1,2]Samrat Ashok Technological Institute Vidisha MP 464001

***Abstract* - Traffic congestion is a major problem at an intersection in urban areas. Due to the day by day increase in the growth of vehicular traffic the load on the existing intersections are increasing and causing the Jam condition for movement of vehicles. The traffic in Bhopal city is increasing day by day and the condition is now reached to upgrade the intersection. In this paper an attempt is made to solve the problem of traffic congestion and unusual delay to the traffic movement at Prabhat Square Raisen Road Bhopal by suggesting the design of fixed time signal in place of the rotary intersection.**

***Index Terms* - Traffic Rotary, Traffic control signal, IRC Method, Optimum Cycle Time, and PCU.**

I. INTRODUCTION

The Increase in the vehicular traffic is becoming sever problem. And this problem is arriving due to owning of personal motor vehicles. To effectively controlling of this increasing traffic on road some traffic control measures are used on road i.e. traffic rotary, traffic signal, channelization of road etc. but there are some limit of traffic which can be handled by this measures.

At the Prabhat Square the traffic movement data are collected for the week day on various time intervals including the morning and evening peak times by manual counting method. Prabhat Square Bhopal is one of the busiest intersections in Bhopal located on the two important cross roads one is from mp nagar to Bhopal Railway Station and another is Raisen Road itself.

Figure 1: Map of Prabhat Square Bhopal (Source: Google Map)

II. OBJECTIVES

- Find out the capacity of Rotary Intersection
- To provide suggestion for modification of rotary intersection if required.

A. ROTARY INTERSECTION

A rotary intersection or Traffic rotary is an enlarged road intersection where all converging vehicles are forced to move around a large central island in one direction (clock wise direction) before they can weave out of traffic flow into their respective direction radiating from the central island.

The main objective of providing a rotary is to eliminate the necessity of stopping vehicle even for cross streams of vehicle and to reduce the area of conflict.

Traffic rotaries can handle traffic volume from 500 PCU/hour to 3000 PCU/hr

B. TRAFFIC SURVEY AND DATA COLLECTION

The traffic data is collected by manual method by counting the number of different types of vehicle approaching to the intersection from all the four directions and then converting the values in to the common factor called Passenger Car Unit (PCU).

The traffic data is collected from 7 days of the week in different time intervals in summer days and the traffic data for calculation of the traffic rotary capacity is taken from the morning and evening peak hour. (Table 1)

Table 1: Number of vehicle approaching at intersection from different direction (in PCU)

Approach	Left Turning	Straight	Right Turning	Total
Ashoka Garden (N)	420	508	366	**1294**
Indrapuri (E)	679	588	289	**1556**
Shubhas Phatak (S)	500	481	717	**1698**
Pull Bogda (W)	438	780	510	**1728**
Total	**2037**	**2357**	**1882**	**6276**

C. CAPACITY OF ROTARY

The practical capacity of the rotary is dependent on the minimum capacity of the individual weaving section the capacity is calculated from the formula:

$$Qp = \frac{280W\left(1+\frac{e}{W}\right)\left(1-\frac{p}{3}\right)}{1+\frac{W}{L}}$$

Where,

Qp = practical capacity of the weaving section in pcu per hour.

W = width of weaving section (6 to 18m)

$W = \frac{e1+e2}{2} + 3.5\text{m}$

e = average width of entry e_1 and width non weaving section e_2

L = length of weaving section between the ends of channelizing island in m

p = proportion of weaving traffic given by

$p = \frac{b+c}{a+b+c+d}$

a = left turning traffic moving along left extreme lane

d = right turning traffic moving along right extreme lane

b = crossing/weaving traffic turning toward right while entering the rotary

c = crossing/weaving traffic turning toward left while leaving the rotary

a. *Ashoka Garden to Indrapuri (N-E)*

$$e = \frac{8+8.235}{2} = 8.12m$$

$$W = \frac{8+8.235}{2} + 3.5 = 11.61m$$

$$L = 4W = 4 * 11.61 = 46.47m$$

b. *Indrapuri to Shubhas Phatak (E-S)*

$e = 10.202m$
$W = 13.702m$
$L = 54.8m$

c. *Shubhas Phatak to Pull Bogda (S-W)*

$e = 8.235m$
$W = 11.73m$
$L = 46.94m$

d. *Pull Bogda to Ashoka Garden (W-N)*

$e = 7m$
$W = 10.5m$
$L = 42m$

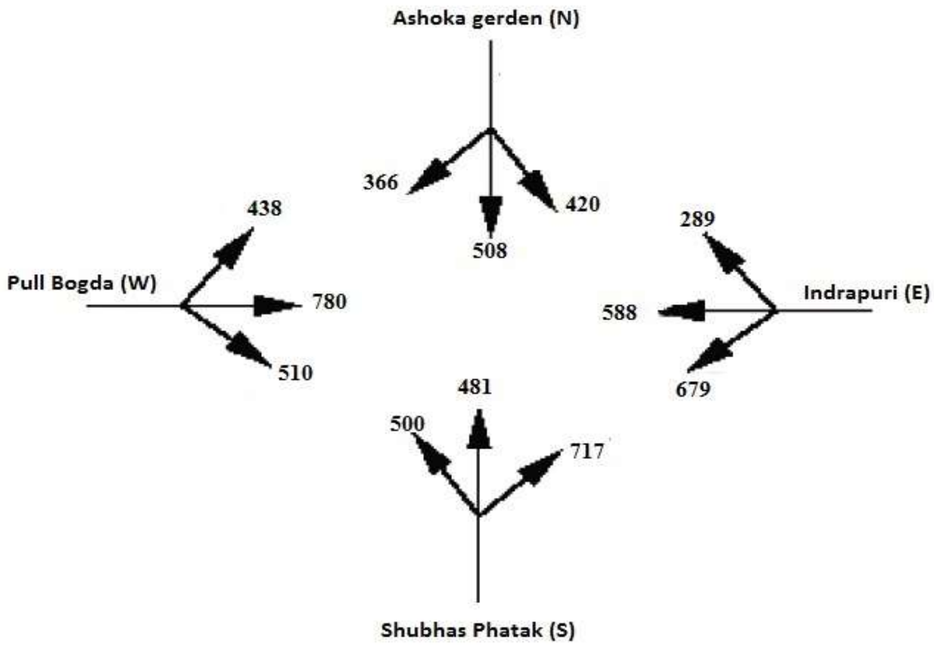


Figure 2: Traffic approaching the Rotary

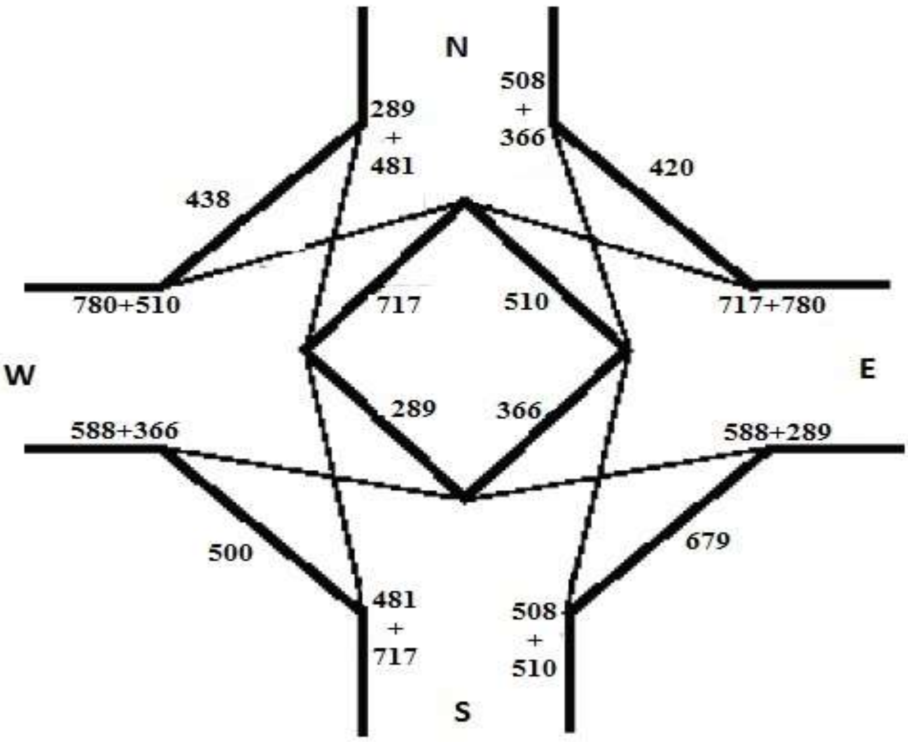


Figure 3: Traffic negotiating a rotary

$$P_{NE} = \frac{366+508+717+780}{366+508+780+717+420+510} = 0.718$$

$$P_{ES} = \frac{588+289+508+510}{588+289+508+510+679+366} = 0.644$$

$$P_{SW} = \frac{481+717+588+366}{481+171+588+366+500+289} = 0.731$$

$$P_{WN} = \frac{289+481+780+510}{289+481+780+510+438+717} = 0.640$$

Now find out the Capacity of Rotary

$$Qp = \frac{280W\left(1+\frac{e}{W}\right)\left(1-\frac{p}{3}\right)}{1+\frac{W}{L}}$$

Capacity of rotary intersection for Ashoka garden to Indrapuri Section

$$\boldsymbol{Qp(NE) = 280 * \frac{11.61(1+\frac{8.12}{11.61})\left(1-\frac{0.718}{3}\right)}{1+\frac{11.61}{46.47}} = 3362}$$

Capacity of rotary intersection for Indrapuri to Shubhas Phatak Section

$$\boldsymbol{Qp(ES) = 4204}$$

Capacity of rotary intersection for Shubhas Phatak to Pull Bogda Section

$$\boldsymbol{Qp(SW) = 3382}$$

Capacity of rotary intersection for Pull Bogda to Ashoka Garden Section

$$\boldsymbol{Qp(WN) = 3083}$$

The capacity of rotary is the minimum of the capacity of all the weaving section. Now it is seen from the above result that the maximum capacity of the rotary is 3083 PCU/hour. And the total traffic entering the intersection is 6276 PCU/hour. Hence in this case the **Signalized Rotary** can be provided which is suggested in this case.

D. TRAFFIC SIGNAL

Traffic signals are one of the most effective and active control systems of traffic and are widely used in several cities worldwide. The traffic arriving from different direction is separated by time, segregation.

Traffic signals are the control devices which could alternately direct the traffic to stop and proceed at intersection using red and green traffic light signals automatically.

E. PHASE DESIGN

The objective of phase design is to separate the conflicting movements in an intersection into various phases, so that movements in a phase should have no conflicts.

The signal design procedure involves six major steps. They include:
(1) Phase design,
(2) Determination of amber time and clearance time,
(3) Determination of cycle length,
(4) Apportioning of green time,
(5) Pedestrian crossing requirements, and
(6) Performance evaluation of the design obtained in the previous steps.

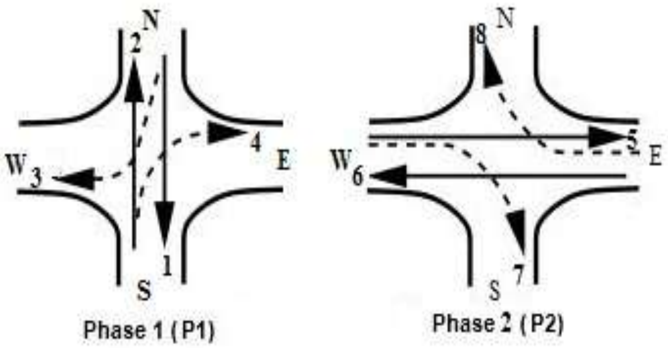
Design method as per IRC Guideline

(i) The pedestrian signal time required for the major and minor roads are calculated based on walking speed of 1.2m/s and initial walking time of 7 sec. These are the minimum green time required for vehicular traffic on minor and major roads respectively.
(ii) The green time required for vehicular traffic on major road is calculated in proportion to the traffic on the two approach roads.
(iii) The cycle time is calculated after allowing amber time o 2.0 sec each.
(iv) The minimum green time required for clearing vehicles arriving during a cycle is a determined for each lane of the approach road assuming that the first vehicle will take 6.0 sec and the subsequent vehicles (PCU) of the queue will be cleared at a rate of 2.0 sec. The minimum green time required for the vehicular traffic on any of the approaches is limited to 16 sec.
(v) The optimum signal cycle time is calculated using Webster's formula The saturation flow values may be assumed as 1850,1890,1950,2250,2550and 2990 PCU per hour for the approach roadway widths (kerb to median or centerline) of 3.0,3.5,4.0,4.5,5.0 and 5.5m; for width above 5.5m, the saturation flow may be assumed as 525 PCU

per hour per meter width. The lost time is calculated from the amber time, inter-green time and the initial delay of 4.0 sec. For the first vehicle, on each leg.

(vi) The signal cycle time and the phases may be revised keeping in view the green time required for clearing the vehicles and the optimum cycle length determined in steps (iv) and(v) above.

Design of 2 phase traffic signal



Critical lane volume of street 1= higher of two approach
=1198/2=599 PCU/hour
Critical lane volume of street 2= higher of two approach
=1290/2=645PCU/hour

Pedestrian clearance time for street 1
= 24/1.2=20 sec
Pedestrian green time for crossing street 1
= 20+7= 27 sec

Pedestrian clearance time for street 2
= 16/1.2=14 sec
Pedestrian green time for crossing road 2
= 14+7= 21 sec

Minimum green time for vehicle on street 2
= 27 sec
Minimum green time for vehicle on street 1
= 599/645*27=25 sec

Adding initial amber and clearance of 2 seconds each for minor as well as major street approaches.
The minimum cycle length works out to
= (2+27+2) + (2+25+2) = 60 sec.

Check for design of signal cycle timing on the basis of vehicular volume

Check for street 1
Number of vehicle per hour per lane = 599
Number of vehicle per lane per cycle of 60 sec
= 599/60= 9.98=10 PCU

Therefore
Green time required for street 1 = 1*6+9*2=24 sec

Since 25 sec green time is provided, it is safe.

Check for street 2

Number of vehicle per hour per lane = 645
Number of vehicle per lane per cycle of 60 sec

= 645/60= 10.75=11 PCU

Therefore
Green time required for street 1 = 1*6+10*2=26 sec

Since 27 sec green time is provided, it is safe.

Optimization of signal timings

The optimum signal cycle is given by:

$$Co = \frac{1.5L + 5}{1 - Y}$$

Where,
L = total lost time per cycle (sec)
Y= Volume/Saturation flow for critical approach in each phase.
$Y=y_1+y_2+\ldots\ldots y_n$
Then,
$g_1=y_1/Y*C_o$
$g_2=y_2/Y*C_o$

L= total amber time + reaction time of both phase
= 8+2*4
= 16 sec

Saturation flow for critical approach in phase 1
= 525*7=3675 PCU/hour

Saturation flow for critical approach in phase 2
= 525*7=3675 PCU/hour

$y_1=599/3675=0.16$
$y_2=645/3675=0.18$
$Y=0.16+0.18=0.34$

Optimum cycle time

$$Co = \frac{1.5L + 5}{1 - Y}$$

$$Co = \frac{1.5 * 16 + 5}{1 - 0.34}$$

Co=43.9
Say 45 sec

$$g1 = \frac{y1}{Y} * 45 = \frac{0.16}{0.34} * 45 = 21\ sec$$

$$g2 = \frac{y2}{Y} * 45 = \frac{0.18}{0.34} * 45 = 24\ sec$$

Effective green time after deducting initial and final amber time

$g_1=21\text{-}2\text{-}2=17\ sec$
But as per pedestrian requirements effective green time for street 1 to cross street 2 is = 25 sec

g_2=24-2-2= 20 sec
But as per pedestrian requirements effective green time for street 2 to cross street 1 is = 27 sec

Therefore
The signal cycle time of 60 sec calculated by IRC method is accepted

Street	Initial Amber	Green	Clearance Amber	Red	Cycle length
Street 1	2	25	2	31	60
Street 2	2	27	2	29	60

III. RESULT AND CONCLUSIONS

From the analysis of collected data we concluded that the traffic approaching at the intersection is very high exceeding 3000PCU/hour and we know that a rotary can handle a maximum traffic volume of 3000 PCU/hour. So from analysis we can conclude that the existing rotary is not able to handle this much amount of traffic. And if can divide the traffic by introducing traffic signal with the rotary, this will divide the traffic to approximately half of the traffic which is currently approaching to the intersection.

So the two phase traffic signal with the total cycle time of 60 sec will be installed with the rotary so the rotary can handle this much of traffic volume.

REFERENCES

[1] Khanna, S.K., And Justo, C.E.G., (2011), “Highway Engineering”, New Chand And Bros, 9th Edition, New Delhi.
[2] Dr. L.R. Kadiyali , “ Traffic Engineering and transport planning ” , 8th edition , New delhi.
[3] Veethika Gomasta, Mohit Malviya, Abhishek Singh and Saleem Akhtar, “Design and Analysis of Intersections for Improved Traffic Flow at Bhopal-Case Studies of Jyoti Talkies Square and Vallabh Bhawan Roundabout” | International Journal of Current Engineering and Technology, Vol.5, No.6 (Dec 2015) .
[4] Tom V. Mathew and K V Krishna Rao, “Introduction to traffic engineering, traffic signal design-II” (NPTEL, May 3, 2007).
[5] Dr. Tom V. Mathew “Design Principle of Traffic Signal” IIT Bombey (Feb 19 2014).
[6] IRC: 93-1985 “Guidelines on Design and Installation of Road Traffic Signals”.