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Analysis of Traffic Signal in the Planned City

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***Abstract* - Road traffic has been growing at a very rapid pace in India during the past there decades. The number of motor vehicles has been growing at a rate around 10% per annum. As a result of the steep growth of motor vehicle population, the traffic on the roads has been increasing both in terms of volume and intensity. The traffic on the roads has reached chaotic conditions in many cities leading to congestions, delays, increased vehicle operation costs and also greater road accident occurrence.sector 14-15, staggered intersection the red time is more than the normal, the people have to wait more to pass the intersection, to overcome this problem, study has been taken out to minimum the delay period of time of the intersection. That is why in recent times it has attracted the attention of Chandigarh Traffic Police and Police Department to adopt the suitable measure to improve the intersection for smooth and safe flow of traffic.With an aim to improve the intersection, various field studies e.g. volume study, and study of other features are carried out in detail and analyzed. Based on analysis of traffic data, some recommendations have been made to improve the traffic flow, which may be proved to be helpful to Chandigarh Traffic Department. The side at sector 14-15 staggered intersection for smooth flow minimization of delaying period of time is recommended. .All the measures recommended in this thesis will certainly help in a big way to improve the flow of traffic at this staggered intersection. Hence intersections being an important part of road systems should be designed in such a way as to reduce conflicts, traffic jams and accidents. Intersection area should not obstruct the smooth flow of traffic, especially during morning/evening peak hours.The problems is further complicated with the tremendous increase in number of cars and two wheelers for personal mobility and the growth of satellite towns on the periphery of Chandigarh. The traffic behaviour on staggered intersections put up an interested subject for study and investigation.**

SIGNALISED SECTOR 14-15 STAGGERED INTERSECTION

The site selected for the present study is sector 14-15 staggered intersection situated at one end of the Madhya Marg. The salient features of the site are described as below:-

1. This intersection has two T-intersection i.e. Intersection 1 (sector 14 side) and Intersection 2 (sector 15 side). The centre to centre distance between these two intersection is 68.5m.
2. This intersection is formed by the intersection of V3 road between sectors 14-15 and a V4 road running from across sector 14 to 15.
3. On one end of the v3 road is Madhya marg and a rounabout between sector 14,15,11 & 12. On the other end of the V3 road is Udyog Path and another large rotary between sector 14,15,24 & 25. On both side of the V3 road there are trees and green belt.
4. Along V3 there is no space for expansion due to busy market centre onone side and houses on other.
5. The left side of V3 road is occupied by panjab university hostels and residential area.
6. On the right side of V3 road there are houses of sector 15 with rows of trees and green belt till meet the roundabout at Udyog path.

PEAK HOUR SIGNAL DESIGN

GENERAL

Design of signal scheme includes selection of type of signals, number of phases, amber period, cycle time and time allotted to each phase of signal and other specified features such as exclusive turning phase or pedestrian phase. The choice of signal at this intersection is fixed time isolated signal type. Based on the field traffic studies data, the signal timings are calculated by Webster's method as modified by IRC. This is a rational approach and it gives the optimum cycle time with minimum delay to the vehicles. Timings have been calculated for both the intersections separately and based on the results a detailed discussion and analysis has been carried out.

REDESIGN OF SIGNAL TIMINGS

STAGGERED INTERSECTION BETWEEN SECTORS 14-15

The staggered intersection consists of two T-intersections. For design purposes these to T-intersections have to be designed separately. Sector 15 leg of the intersection is taken as intersection I and sector 14 leg of the intersection as intersection 2. The three phases that exists at intersection I are:

Phase I : SECTOR 11-12 SIDE

Straight towards sector 24-25, Left towards sector 15 and & Straight towards sector 11-12 from sector 24-25.

Phase II : SECTOR 15 SIDE

Left towards sector 24-25, Right towards sector 11-12 & Left from sector 11-12..

Phase III: SECTOR 24-25 SIDE

Straight towards sector 11-12, Right towards sector 15 & Left from sector 15.

Similarly phasing exists at intersection 2 also in opposite direction.

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7.2.1 Calculation of Saturation flow

Saturation flow for traffic from different roads in PCUs/Hour has been worked out taking into account the good side characteristics and as such saturation flow values has been taken as 120% of the standard value.

CALCULATION OF Y VALUE

INTERSECTION – 1 (SECTOR- 15 SIDE)

From	SECTOR 11-12 SIDE			SECTOR 15 SIDE			SECTOR 24-25 SIDE		
To	L	S	R	L	S	R	L	S	R
Present traffic flow pcu/hr	211	581 225	-	248 161	-	229	-	1218 252	244 68
Correction for left turner (+25%)	53			103					
Phase I Total flow (q_1)		1070							
Saturation flow (s_1)		4725							
Y value , $Y_1 = q_1/s_1$		0.3							
Phase II Total flow (q_2)				512		229			
Saturation flow (s_2)				4769		1961			
Y value $Y_2 = q_2/s_2$				0.107		0.11			
Phase III Total flow (q_3)								1470	312
Saturation flow (s_3)								4845	3269
Y value $Y_3 = q_3/s_3$								0.30	0.095

INTERSECTION – 2 (SECTOR- 14 SIDE)

From	SECTOR 24-25 SIDE			SECTOR -14 SIDE			SECTOR 11-12 SIDE		
To	L	S	R	L	S	R	L	S	R
Present traffic flow pcu/hr	455	1218 244	-	252 68	-	367	-	581 248	225 161
Correction for left turner (+25%)	114			80					
Phase I Total flow (q_1)		2031							
Saturation flow (s_1)		4845							
Y value , $Y_1 = q_1/s_1$		0.42							
Phase II Total flow (q_2)				400		367			
Saturation flow (s_2)				3969		1961			
Y value $Y_2 = q_2/s_2$				0.10		0.19			
Phase III Total flow (q_3)								829	386
Saturation flow (s_3)								4725	3269
Y value $Y_3 = q_3/s_3$								0.18	0.12

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CALCULATION OF OPTIMUM CYCLE LENGTH
INTERSECTION – 1 (SECTOR -15 SIDE)

Based on the approach speed at the Intersection and as per British Practice, the following assumptions can be made:

Inter Green Period 1 = 4 seconds

Amber Period a = 3 seconds

Time Lost due to starting delays 1 = 2 seconds per phase

Total lost time per cycle L is calculated below:

L = ∑ (I-a) + ∑1

L = 3 (4-3) + 3x2 (Number of phases = 3)

L= 9 seconds

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L= 9 seconds

Optimum cycle length Co is calculated below:

$$Co = \frac{1.5\,L + 5}{1 - Y_1 - Y_2 - Y_3}$$

$$Co = \frac{1.5 \times 9 + 5}{1 - 0.42 - 0.19 - 0.18}$$

Co= 88.09 seconds

Co =~ 88 seconds

7.2.4 GREEN TIME APPORTIONMENT

Now appropriate green time for each phase shall be computed. It has been found that least delay occurs when the effective green time for each phase is proportional to its Y Value. The above rule gives:

$$g = \frac{Yn}{Y_1 + Y_2 + \dots\dots + Yn} \times (Co - L)$$

Co = Optimum Cycle Length

L = Total Lost Time per Cycle

Co-L = Effective Green Time

INTERSECTION – 1 (SECTOR -15 SIDE)

Phase 1

Here Green Time required by pedestrians is less than the time available based on the traffic criterion, so there is no need to give more time to pedestrians.

As per IRC guidelines, the minimum green time required for the vehicular traffic on any of the approached is limited to 16 sec. Therefore, increase green time to 16 sec. Hence,

g_1 = 23 Sec

g_2 = 16 Sec

g_3 = 23 Sec

Taking Amber period as 3 seconds after each green time.
New cycle length = 23 + 3 + 16 + 3 + 23 + 3

= 71 sec

As per H.M.S.O “Technical paper Number 56” the cycle length is in between 0.75 Co to 1.5 Co. Hence, the delay will not more 10 to 20% above that given by optimum cycle. Total green time including Amber Time are:

Gn = gn + 2

G1 = 23 + 2 = 25 sec

G2 = 16 + 2 = 18 sec

G3 = 23 + 2 = 25 sec

Controller setting for various phases: Gn – a
Phase I : 25 – 3 = 22 sec

Phase II : 18 – 3 = 15 sec

Phase III : 25 – 3 = 22 sec

The timing and phasing diagrams are given in figure 7.1

INTERSECTION – 2 (SECTOR- 14 SIDE)

Phase 1

Here Green Time required by pedestrians is less than the time available based on the traffic criterion, so there is no need to give more time to pedestrians.

As per IRC guidelines, the minimum green time required for the vehicular traffic on any of the approached is limited to 16 sec. Therefore, increase green time to 16 sec. Hence,

g_1 = 42 Sec

g_2 = 19 Sec

g_3 = 18 Sec

Taking Amber period as 3 seconds after each green time.

New cycle length = 42 + 3 + 19 + 3 + 18 + 3
= 88 sec

As per H.M.S.O "Technical paper Number 56" the cycle length is in between 0.75 Co to 1.5 Co. Hence, the delay will not more 10 to 20% above that given by optimum cycle. Total green time including Amber Time are:

Gn = gn + 2

G1 = 42 + 2 = 44 sec

G2 = 19 + 2 = 21 sec

G3 = 18 + 2 = 120 sec

Controller setting for various phases: Gn – a
Phase I : 44 – 3 = 41 sec

Phase II : 21 – 3 = 18 sec

Phase III : 20 – 3 = 17 sec

INTERLINKING IN DESIGN OF SIGNAL

This staggered intersection is divided into two-T-intersection intersection 1 (PGI side) and Intersection 2 (PU side). The phase signal timing has been designed separately. If these T-intersection are not co-ordinated, there would be queuing of vehicles, congestion and delay. In order to avoid queuing of vehicles, reduce delay to traffic and smooth flow of traffic, these T-intersections should be interlinked. The green time for each of the phase was found out to be same i.e. 16 sec. The inner to inner distance between the intersection is 23m and centre to centre distance is 44 m. If a vehicle move at a speed at 45 kmph, there is only 3.5 sec required to cross this intersection. Since green time is same for each of the phase and distance is very less, the simultaneous system signal for interlinking is suitable and used. In this system, signal along controlled section display the same aspect to the same stream at the same time. Thus, phase I, II, and III of Intersection 1 interlinked with phase I, II and III of Intersection 2 respectively.

CRITICAL REVIEW ANALYSIS AND DISCUSSION

8.1 Comparision of Redesigned And Existing Timing of the Intersection 14-15

INTERSECTION 1 (sector 15 side)

ROAD	PHASE	SIGNAL ASPECT	EXISTING SIGNAL TIME (SECONDS)	REDESIGNED SIGNAL TIME IN PEAK HOURS	REDESIGNED SIGNAL TIME IN NON PEAK HOURS
Sector 11-12 side		GREEN AMBER RED	30 3 52	22 3 46	15 3 39
Sector 15 side		GREEN AMBER RED	14 3 60	15 3 53	15 3 39
Sector 24-25 side		GREEN AMBER RED	50 3 23	22 3 46	15 3 39

INTERSECTION 2 (sector 14 side)

ROAD	PHASE	SIGNAL ASPECT	EXISTING SIGNAL TIME (SECONDS)	REDESIGNED SIGNAL TIME IN PEAK HOURS	REDESIGNED SIGNAL TIME IN NON PEAK HOURS
Sector 24-25 side		GREEN	21	41	15
		AMBER	3	3	3
		RED	51	44	39
Sector 14 side		GREEN	14	18	15
		AMBER	3	3	3
		RED	60	67	39
Sector 11-12 side		GREEN	50	17	15
		AMBER	3	3	3
		RED	23	68	39

CUMULATIVE DELAY TIME

INTERSECTION 1 (sector 15 side)

ROAD	PHASE	CUMULATIVE EXISTING SIGNAL TIME (pcu.sec)	CUMULATIVE REDESIGNED SIGNAL TIME IN PEAK Hrs.	CUMULATIVE REDESIGNED SIGNAL TIME IN NON PEAK Hrs.
Sector 11-12 side	1	RED TIME*PCU 52884	RED TIME*PCU 46782	RED TIME*PCU 39663
Sector 15 side	2	38280	33814	24882
Sector 24-25 side	3	44091	88182	74763

INTERSECTION 2 (sector 14 side)

ROAD	PHASE	CUMULATIVE EXISTING SIGNAL TIME (pcu.sec)	CUMULATIVE REDESIGNED SIGNAL TIME IN PEAK HOURS (pcu.sec)	CUMULATIVE REDESIGNED SIGNAL TIME IN NON PEAK HOURS (pcu.sec)
Sector 24-25 side	1	RED TIME*PCU 97767	RED TIME*PCU 84348	RED TIME*PCU 74763
Sector 14 side	2	41220	46029	26793
Sector 11-12 side	3	23391	69159	39663

CRITICAL REVIEW, ANALYSIS AND DISCUSSION ON STAGGERED INTERSECTION BETWEEN SECTOR 14-15 CRITICAL REVIEW

The intersection has been observed critically during peak hours and normal hours and studied for layout, traffic problems and signal timing with an eye for scope of improvement and accordingly following facts have been brought out.

Signal timing, existing and redesigned are at much variance. The redesigned signal timing are very less than existing timings. This intersection has been signalized an year back. The present timings are more than the requirement thereby causing a lot of delay to the traffic.

Inspite of more signal timing provided long queues from on the approaches of the intersection. This is due to the insufficient road widths. This intersection has been signalized without altering its geometric layout. If the road widths have been adequate, there would be no need for such a large timing scheme and side by side no queues will be formed on any of the approaches. Due to the insufficient road width, left turners on any of their approached do not get separate lanes for turning left. V4 lanesfrom sector 14 is only 6.3 meter wide which is very less for peak hour traffic volume. Road width on V3 leg from sector 24-25 is 7.69 meter and traffic on this leg is very large. This leads to formation of long queues. There are no separate lanes for left and straight going traffic causing lot of delay to people.

ANALYSIS

The present intersection is causing lot of delay to traffic. Signal timings provided here are more than required. The road widths of all the approaches have to be increased, as it is very insufficient for a signalized intersection. Traffic in the morning is moving mainly towards sector 14 and is at peak fromfrom 8.45 a.m. to 9.45 a.m. In evening , traffic moves away from sector 14 and is at peak from 4.45 p.m. to 5.45 p.m.in evening, there is heavy rush of right turning traffic from sector 11-12 and turning right towards sector 14. These two turning movements of traffic thus become the main guiding factor for the intersection design. Capacity of an intersection for right turning traffic can be increased by making it a double file stream from a single file stream. Thus the approach roads need widening and redesigning of signal timings accordingly.

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The basic purpose of providing a staggered intersection is defeated as soon as it is signalized. A staggered intersection thus becomes a source of longer delay and an accident prone area . Conceptually the staggered intersection were provided in the city of Chandigarh with a view that all the flow of traffic throughout the city will be free with various measures taken from time to time to improve the flow of traffic without actually going in for signalization. The staggered intersection were provided on V3 –V4 road so as to reduce the speed of vehicles on V4 road while crossing or joining V3 without actually reducing the speed of traffic moving on V3 .

CONCLUSION

The study conducted on the two intersection brings out the following points clearly :

1. Signal timing provided at the sector 14-15 staggered intersection is very large as compared to the required timings. This causes a lot of delay to the vehicular traffic.
2. Capacity of this intersection can be increased by redesigning the geometric layout of the intersection. So widening of approach widths can increase the capacity of intersection as required by peak hour traffic volume.
3. V4 roads of sector 14-15 staggered intersection are redesigned to be minimum two lane roads of width 7.5 m. Similarly V3 roads are required to be minimum three lane roads of width 10.5 m .
4. Staggered intersection between sectors 14-15 forces longer delays on straight going traffic. Firstly because a staggered intersection itself takes longer time to clear and secondly because it's a Left-Right type instead of the better Right- left type. Above these two factors the signal timing scheme provided at this intersection is more than required. So it requires immediate modifications.

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