Analysis of an Unsignalized Intersection in Ahmedabad city

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Abstract: **Unsignalized intersections are the bottleneck points of any traffic network, generally found in different traffic conditions. They are mostly a cause for accidents at intersections especially in a country like India where the traffic rules are not strictly obeyed. Capacity of the intersection is required to be calculated to ensure a smooth flow of traffic with minimum conflicts. The study area selected for the analysis was CCD cross roads near Shyamal in Satellite area of Ahmedabad. Analysis has to be done by collecting Traffic Volume data to determine the number, movements, and classifications of roadway vehicles. These data help identify critical flow time periods, the effect of large vehicles or pedestrians on vehicular traffic stream, level of service of intended facility.**

Signal timing is a technique used by traffic engineers to find the right-of-way at an intersection. Signal timing involves deciding allocation of green time at an intersection approach, the pedestrian walk signal, and various other factors. There are different methods for signal design. Webster's method of signal design is simple, reliable and based on formulae introduced by Webster. In this method, the total cycle length of the signal is determined which results in minimum delay at the intersection.

Keywords: **unsignalized, intersection, signal design, cycle length, saturation flow, delay.**

1. INTRODUCTION

In developing countries like India the traffic is usually mixed/heterogenous traffic, consisting of vehicles of different categories. These vehicles vary in sizes and speeds. These characteristics mostly affect the flow and the capacity of traffic. The traffic flow can be easily maintained to be a smooth flow if the traffic volume at an unsignalized intersection is within the saturation limit. But if the volume at the intersection is higher, then it becomes quite difficult to control the flow and there are certainly chances of congestion at such intersections. The estimation of capacity at such an intersection is the most important feature which help solving such problems. Capacity estimation at such intersections is usually more complicated than at signalized intersections. This is due to the fact that the speed at an un-signalized intersection vary at a greater degree. The speed on the major road is usually higher than the estimated speed. The vehicles approaching from the minor road may thus conflict with those coming from the major road as the signal is uncontrolled. The present site would be analyzed with the help of road inventory data and traffic volume study.

2. METHODOLOGY

For the analysis of the selected intersection, firstly road inventory data has been collected. Traffic analysis is carried out with the help of video recording method for traffic volume count. Traffic Volume study has been carried out for peak hours in the morning and in evening. 9:00 AM to 12:00 AM in the morning and 4:00 PM to 6:00 PM in the evening is the selected time range. From the analysis of the data, hourly PCU values and V/C ratios would be calculated. Critical flow periods would be determined. If needed, signal design would be carried out by Websters Method.

3. LOCATION DETAILS

The study area selected for the analysis is a four-legged unsignalized intersection in Satellite Area of Ahmedabad. It is one of the busiest intersections with frequent traffic jams. For convenience in analysis intersection site is given notation "A". Names are given to its approach lanes as A1, A2, A3, A4.

Fig. 1: Study Area
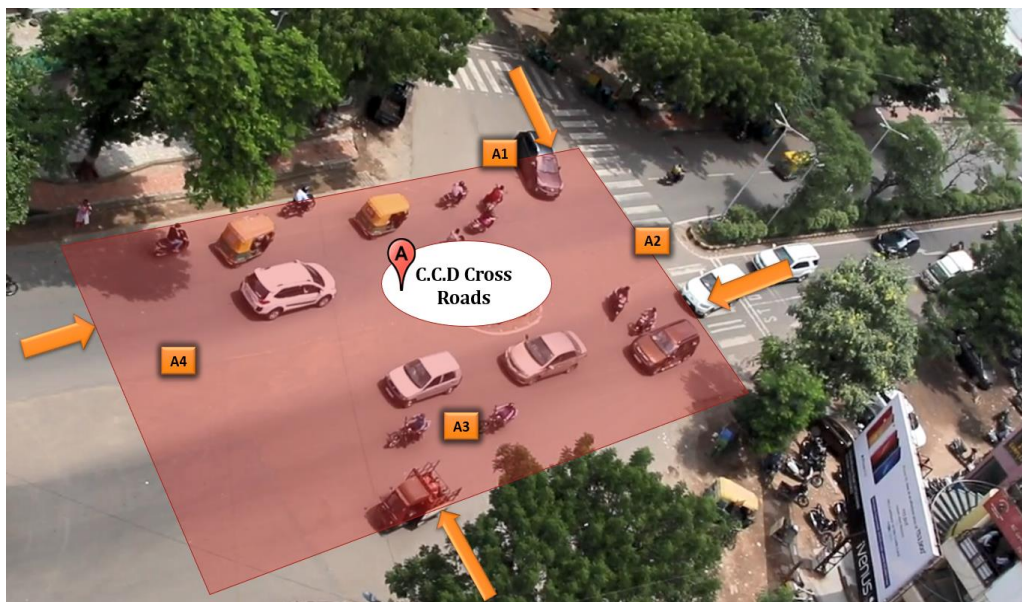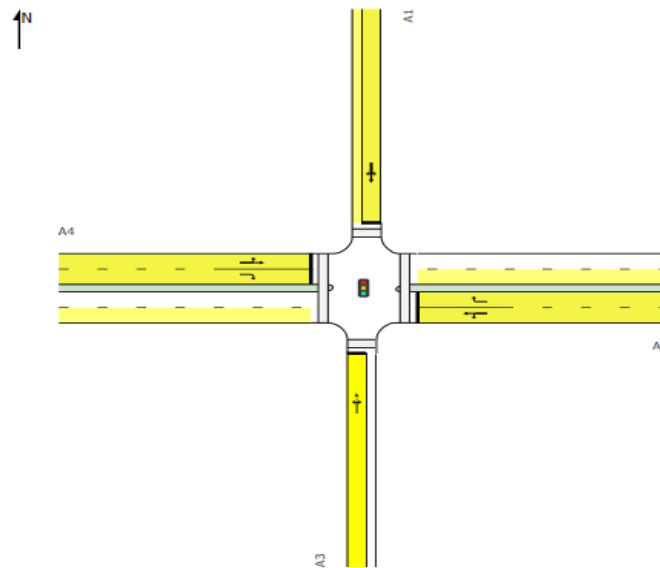

Fig. 2: Intersection A with Approach Lanes

4. DATA COLLECTION

4.1. Road Inventory Data

Traffic volume has been counted with the help of video recording method. All the traffic movements viz. left turn, through and right turn movements are taken into consideration. Based on vehicular composition percentage, these volumes are converted into PCU values in veh/hr. For calculation of PCU values IRC 106:1990 for urban roads is used.

TABLE 1: Type of Road

Approaches	Road Type	Approach Lengt (m)	Approach Width(m)
A1	2-lane undivided	300	8
A2	4-lane divided	464	15
A3	2-lane undivided	388	8
A4	4-lane divided	390	15

Fig. 3: Approach Lanes Details

4.2. Traffic Volume Count

Traffic volume has been counted with the help of video recording method. All the traffic movements viz. left turn, through and right turn movements are taken into consideration. Based on vehicular composition percentage, these volumes are converted into PCU values in veh/hr. For calculation of PCU values IRC 106:1990 for urban roads is used.

TABLE 2: Hourly volume obtained

Approach	Time	PCU(veh/hr)	Approach	Time	PCU(veh/hr)
A1	09:00-10:00	1009.50	A3	09:00-10:00	840.15
	10:00-11:00	1006.65		10:00-11:00	1140.55
	11:00-12:00	1004.55		11:00-12:00	745.55
	16:00-17:00	851.60		16:00-17:00	871.40
	17:00-18:00	1054.05		17:00-18:00	824.10
	18:00-19:00	1295.00		18:00-19:00	800.00
A2	09:00-10:00	3609.45	A4	09:00-10:00	2798.30
	10:00-11:00	4138.15		10:00-11:00	4182.05
	11:00-12:00	3238.80		11:00-12:00	2940.00
	16:00-17:00	2894.10		16:00-17:00	2960.00
	17:00-18:00	3664.80		17:00-18:00	3148.40
	18:00-19:00	2665.85		18:00-19:00	3165.70

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5. ANALYSIS

From the traffic volume count data, it is observed that the vehicular traffic along minor road approach is within saturation limits. The problem of traffic congestion arises due to the traffic on major road approach which crosses the saturation limits as per IRC 106:1990 which is 1950 PCU/hr for minor road approaches and 3937.5 PCU/hr for major road approaches. Thus, there is a need for traffic signal in order to smoothen the traffic flow. Signal timings are calculated as per Websters method. A two-phase signal is suggested and designed as per the procedure.

Websters Formula for calculating cycle length is given by,

$$C = \frac{nL}{1 - \frac{y}{S_i}} \qquad (1)$$

where C= Optimum cycle length(s),

n= number of phases,
L= Total lost time(s),
y= Normal flow(veh/hr),
S_i= Saturation flow rate(veh/hr).

Assume, Saturation headway h= 2 seconds,

Total lost time L= 2.5 seconds,
Amber time=2 seconds

$$S_i = \frac{3600}{h} \qquad (2)$$

From Equation 1, Si= 3600/2= 1800 veh/hr. So the intersection could handle 1800 veh/hr at a time. A two phase signal is to be is suggested to be designed. A1-A3 is the minor lane and A2-A4 is the major lane. Sum of critical lane volumes ∑Vc= 1295+4182=5477, which is way higher than Si and which gives negative cycle time which is incorrect. Hence the traffic from both the lanes has to be reduced. Let the traffic in the major lane be allowed to flow in 4 lanes and in the minor lane in 3 lanes.
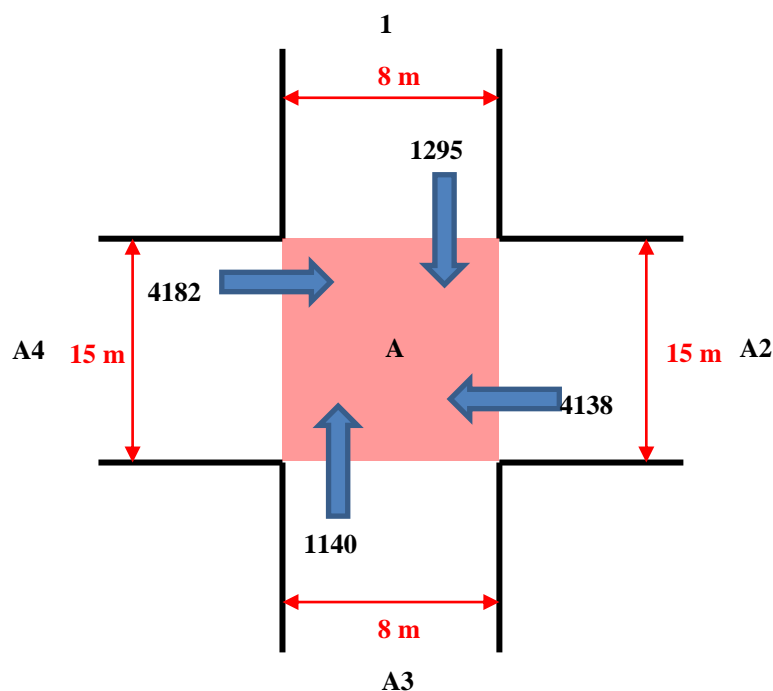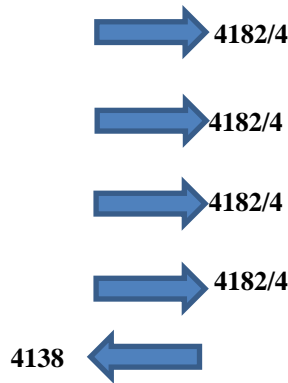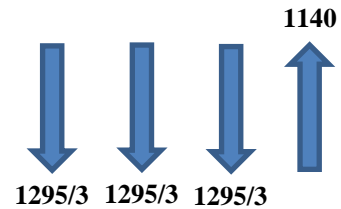

Fig. 4: Traffic Distribution

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Fig. 5: Phase 1   **Fig. 6: Phase 2**

From Equation 1, Total cycle time C=(2*2.5)/(1-(1467/1800)), which gives C= 27 seconds.

Now the total critical volume= 1035+432=1467 veh/hr, which is less than Si. Effective Green time Gi can be found out by following equation,

$$G_i = C - nL \qquad (3)$$

From Equation 3, Gi= 27-(2*2.5)=22 seconds

Green time for phase 1 $g_1 = 22 \times \frac{1035}{1800}$ =18 seconds

Similarly, $g_2 = 22 \times \frac{432}{1800}$ =9 seconds

Actual cycle time C_a = (2+18+2) + (2+9+2) =35 seconds
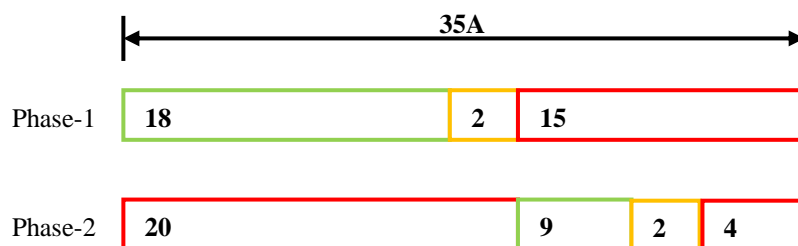
Thus, the phase diagram is as follows:

Fig. 7: Timing Diagram

6. CONCLUSION

The intersection in the study area faces the problem of traffic congestion, especially because of major road traffic. This is because the major approach road receives a large vehicle platoon from previous consecutive closely placed intersections. Thus, a two-phase signal is required to maintain smooth traffic flow, which is designed as per the procedure above.

Total cycle time=35 seconds,

Phase 1: G=18 seconds, A=2 seconds, R=15 seconds

Phase 2: G=9 seconds, A=2 seconds, R=24 seconds

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