Influence of Signal Coordination on travel time and delay

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***Abstract*- Traffic on the existing road increasing due to rapid urbanization and industrialization has caused extremely growth of vehicles all over the world. Due to this, some problems like congestion, delay and pollution remain in question if the signal is not coordinated. The basic function of most arterial streets and roadways is to move traffic safely and efficiently with minimum delay. The main source of delay and congestion along most arterial streets and roadways are traffic signals. Too often motorists are required to make unnecessary stops because adjacent traffic signals bear no relationship to each other. This results in longer travel times and increased vehicle emissions and fuel consumption which reduce air and noise pollution. Coordination of signal is achieved when a platoon achieve green phase at successive intersections. In this paper coordination is done by time space diagram of various cycle lengths.**

***Index Terms*— Time space diagram, Cycle length, Signal coordination, Delays.**

I. INTRODUCTION

Coordination of signal is one kind of traffic management measure. The benefit of traffic signal coordination is based on the relationship between the prevailing speed of vehicles on the main street, the spacing of/distance between traffic signals, the hourly traffic volume on a major street, hourly traffic volumes on the side streets, and number of non-signalized intersections along the roadway system. For the present study a stretch of road with three signalized intersection located in Ahmedabad city has been selected for applying coordination of signal and methodology will be developed to analyze a traffic stream characteristics for a selected stretch of road. Changes likely to occur in delays and queue length are determined. Effectiveness of signal coordination is depending on spacing between the signal, traffic flow characteristics and signal cycle length. When signals are spaced too far apart, traffic may not form these platoons thereby undermining the effectiveness of signal coordination. In addition, uneven or closely spaced traffic signals can also reduce the effectiveness of platoon formation therefore reducing arterial travel speeds, resulting in an excessive number of stops, even under moderate traffic volumes.

II. GLOSSARY OF COMMONLY USED TERM

- Signal coordination: Coordination refers to the timing of the signals so that a "platoon" traveling on a street arrives at a succession of green lights and proceeds through multiple intersections without stopping
- Cycle length: The time required for one complete sequence of signal indication is called cycle length.
- Offset: The offset is defined as the difference between the starts of green time at the successive upstream and downstream signal.
- Time space diagram: A two-dimensional representation of the spacing of various signals along a roadway and the signal indications of each of these signals as a function of time.

III. BENEFITS OF SIGNAL COORDINATION

- Improves mobility and access through the area,
- Reduces vehicle accidents in the area;
- Reduces energy and fuel consumption;
- Reduces stops;
- May control travel speeds;
- Provides environmental benefits from reduced vehicle emissions;
- Ability to monitor daily traffic operations;
- Eliminated or delayed street widening needs,
- Reduced vehicle wear,
- Reduced noise and air pollution

IV. LIMITATION OF SIGNAL COORDINATION

Coordination does not mean that there will be no delays for traffic, rather that the level of delay is minimized. This is because:

- As all traffic signals have different traffic flows, and often have different phasing, so the amount of green time available to the coordinated approaches varies along a coordinated route. Therefore, it is often inevitable that some traffic in the platoon is stopped somewhere along the coordinated route.
- It is necessary to start the green period on the coordinated route sufficiently in advance of the arrival of the platoon to allow any queues of traffic stopped at the downstream traffic signals to clear. These times accumulate for subsequent traffic signals along the route, progressively reducing the green-time available for the original platoon.
- Coordination cannot improve the capacity of an intersection above that it would have under independent operation. However, it can improve the capacity of intersections that are closely spaced and therefore have strongly interacting traffic queues.
- Outside periods of strong "tidal" traffic flow (i.e. outside peak hours) traffic along arterial roads is typically balanced, so two-directional coordination is required. It is extremely rare that intersection green times, spacing and travel time align to allow for complete two-way coordination. Normally a compromise coordination plan is required, which minimizes (i.e. does not reduce to zero) stops and delays in both directions.

V. DATA COLLECTION FOR THE STUDY

1. Classified volume count: CVC study has been carried out for morning and evening peak hours by videography and somewhere by manually.
2. Stopped delay study: stopped delay survey at intersection is carried out manually and simultaneously with volume count study.
3. Speed density relation: speed density relation is carried out near intersection as well as midblock of two intersections.

VI. METHODOLOGY ADOPTED FOR SIGNAL COORDINATION

For the proposed study of coordination of signal a link of three signalized intersections of four arms are selected. The stretch length is 1.8 kilometers and the spacing between two signalized intersections is 900m. Classified volume count survey and stopped delay survey has been carried out from these data Saturation flow rate is also determined. After that signal design is carried out. In this study signal is designed by using Webster's method. Signal is designed mainly for three conditions: heavy flow, average flow and minimum flow. For heavy flow signal cycle is 180sec, for average flow it is 120sec and for minimum flow cycle length is 80sec. for drawing time space diagram average traffic condition and 120sec cycle should be considered. The time-space diagram is a chart that plots ideal vehicle platoon trajectories through a series of signalized intersections. The locations of intersections are shown on the distance axis, and vehicles travel in both directions (in a two-way street). Signal timing sequence and splits for each signalized intersection are plotted along the time axis. It is very important these plots are to scale so that a consistency between units can be maintained. For coordination the cycle length at all intersection should be same, If these uncoordinated cycle lengths vary widely, then traffic signal coordination may not be appropriate or the corridors may be subdivided into multiple systems, each operating on its cycle length. The following fig. shows the time space diagram.

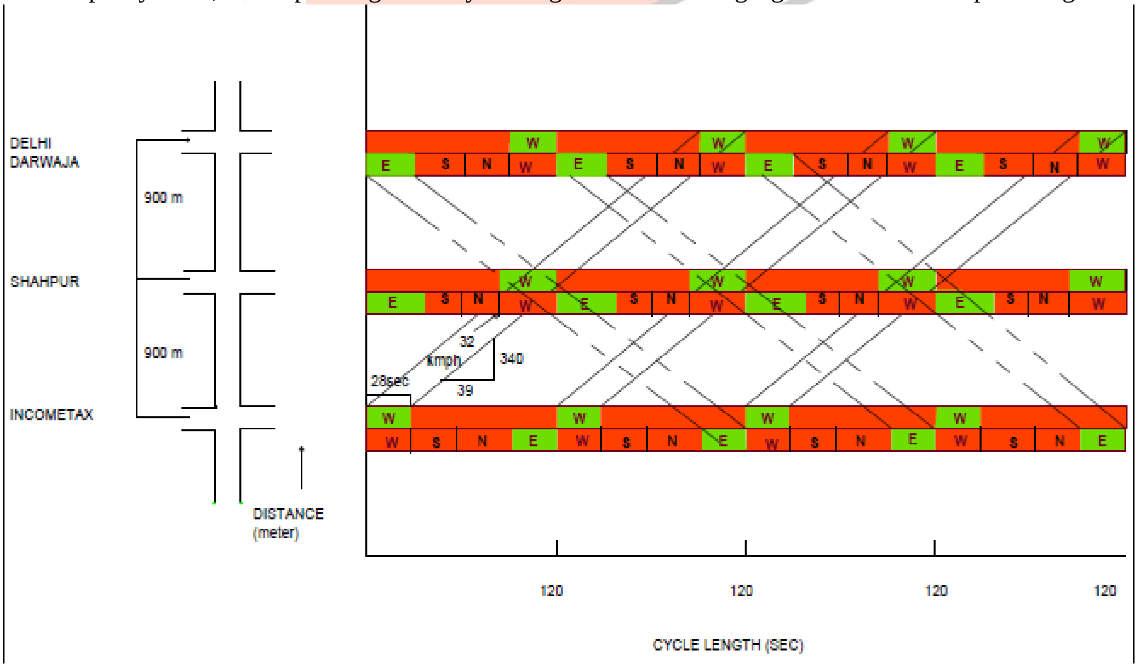

Fig. 1 Time-Space diagram of coordinated timing plan

The result of signal coordination is illustrated on the time-space diagram above. The start and end of green time show the potential trajectories for vehicles on the street. This diagram shows the East and West movement of study area. The solid line shows the West movement and broken line shows the east movement of vehicles. The bandwidth is 28 sec. The slope of this bandwidth gives the speed of vehicle at which it is travelled then it achieve the green time at successive intersection.

VII. TRAVEL TIME CALCULATION

It is a time required by a vehicle to cover a specified distance. Study through videography revealed that under the set of prevailing different types of arrival & departing situations (Saturation flow) speed density & speed flow relations are indicative of the fact that velocity of vehicles along the space stretch varies between 30 to 35 kmph, with different type of vehicular composition.

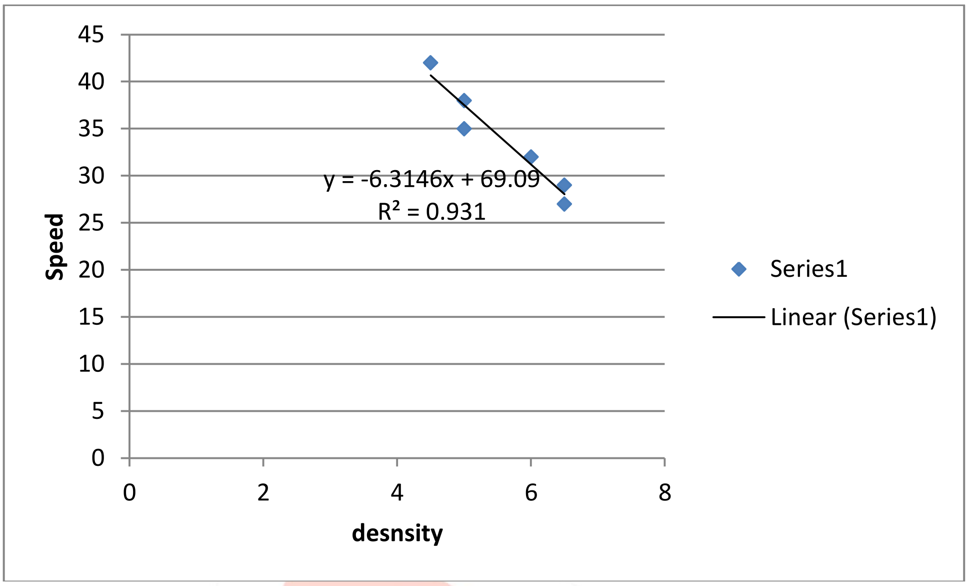

Fig.2 Speed density relation

Figure shows the speed density relation, highest departure rates with different composition showed average vehicular speed over space stretch as 32 kmph. Hence coordinated plan is studied with velocity 32kmph for different types of arrival and departure situations. Travel time is reduced from 116 seconds to 101 by coordination.

For a study area speed is 32kmph and spacing between two intersections is 900m.

$$\mathrm{T.T.} = \frac{distance\ between\ two\ intersection(meter)}{speed\ of\ vehicle\ in\ (mps)}$$

$$\mathrm{T.T.} = \frac{900(m)}{8.89(mps)}$$

Travel time = 101 sec

VIII. STOPPED DELAY

Stopped delay at intersection is defined as numbers of vehicles are stopped at intersection in red time. The following table shows the delay result before and after signal coordination. The result shows that delay is reduced up to 62% by coordination.

Table. 1 Delay comparison before and after coordination

Intersections	Stopped delay before coordination (second)	Stopped delay after coordination (second)
Incometax	99	35
Shahpur	72	31
Delhi Darwaja	81	30

IX. CONCLUSION

Following are the conclusions drawn from the study:

- For coordination of signal minimum cycle length should be considered as longer cycle time increase the delay while small cycle length reduce delay, increase road capacity and reduced the formation of queue. So for this study cycle length of 120 sec gives the best result. Cycle length which is adopted is same for all three intersection of study area.
- From time space diagram it is proved that if vehicle will travel at a speed of 32kmph it achieve green phase at successive intersection.
- Also the stopped delay will reduced as delay in existing situation is 80-90 sec which is reduced up to 35-40 sec. so it can be said that stopped delay is reduced up to 62%.
- The above methodology is appropriate for the fixed time signal and not costly also as no need of soft-wares, sensors, detector or any other arrangement and which is suitable for the Indian traffic condition.

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