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ESTIMATION OF LEVEL OF SERVICE AT SUCHITRA AND KUKATPALLY INTERSECTIONS

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***Abstract:* -- Delay is one of the principal measures of performance used to determine the level of service (LOS) at signalized intersections and several methods have been widely used to estimate vehicular delay. Very few studies only have been carried out to estimate delay at signalized intersections under mixed traffic conditions prevailing in developing countries like India. In the present study various problems associated with delay estimation under mixed traffic conditions in a developing country (India) and the methods to overcome them were discussed and an attempt was made to improve the accuracy estimating the same.**

Uncontrolled intersections are vital points on urban roads, the performance of which will influence the traffic flow on entire network. Delays to vehicles at urban uncontrolled intersections depend upon the several factors, the most important among these being major road approach volume, type of turning movement, and vehicular composition. The average delay caused to vehicles is an important measure to evaluate the performance of uncontrolled intersections. The performance of an uncontrolled intersection is described by the service delay experienced by low priority movements. Under mixed traffic conditions, the traffic compositions, apart from the conflicting traffic volume and proportion of turning traffic are vital factors influencing the service delay. Most of the earlier studies conducted on this subject, pertain to homogeneous traffic environment, and only a few studies with limited scope have been conducted under mixed traffic conditions. In this study, the service delay models have been developed for three uncontrolled intersections located in the city. These models developed were found to be statistically and logically sound. The level of service for the uncontrolled intersections taken under the study has been evaluated using the estimated average service delays from the models developed

***Keywords* -- Delay, Signalized intersections, Mixed Traffic, Saturation Flow, LOS.**

I.INTRODUCTION

Uncontrolled intersections are the intersections which function without any priority assigned to the traffic on any of the intersecting roads, no control (neither STOP signs nor Police-controlled) and the traffic is of heterogeneous nature. These intersections are vital nodal points on urban roads, the performance of which will influence the traffic flow on entire network. Delays to vehicles at urban uncontrolled intersections depend on several factors. The most important among these being the major road approach volume, type of turning movement, and vehicular composition. The extent of intersection of these factors and their collective effect on delay caused to vehicles need to be studied in detailed for better traffic management at these intersections. Field studies due to resources constraint may not include all these, the limited samples that might be obtained will be sufficient to evaluate the effect of various parameters.

At uncontrolled intersections in the absence of indication of specific time intervals to each of the streams of traffic to cross the intersection, the drivers look for gaps and cross the intersections. In developing countries like India, in the absence of the concept of major and minor roads in traffic regulation schemes, vehicles approaching the intersections through all roads, on arrival; assume that equal right to enter the intersection. This has made the traffic situation at the uncontrolled intersection highly complex causing considerable delay to traffic. The delay experienced by vehicles is probably most desirable criteria based on which the performance of the uncontrolled intersection can be evaluated.

Objectives of the Study:

- To establish mathematical relations for service delay to the different types of vehicles for a priority movement at uncontrolled intersections
- To develop the readily usable mathematical model, to estimate the service delay caused to the subject vehicles at urban uncontrolled intersections, considering interactions of various categories of vehicles under heterogeneous traffic environment.
- To evaluate the performance of uncontrolled intersections based on the average service delay.
- To conduct the traffic and delay studies at signalized intersections to evaluate the performance of the signalized intersection
- To determine the aggregate delay of the intersection.
- To establish the level of service (LOS) of the Signalized intersection.
- To analyze the delays and draw meaningful inferences.

LITERATURE REVIEW

Unsignalized intersections make up a great majority of at-grade junctions in any street system. Stop and yield signs are used to assign the right-of-way, but drivers have to use their judgment to select gaps in the major street flow to execute crossings and turn movements at two-way and yield controlled intersections. Two methods are discussed in this section: HCM (2000) Delay method and Blunden's (1961) method.

William (1977) presented a simple and accurate technique for measuring vehicular delay on an approach to a signalized intersection. Precise definitions were established for four measures of performance: stopped delay, time-in-queue delay, approach delay and percentage of vehicles stopping and interrelationships among the four measure of performance were established.

Ternus et al. (1977) developed a procedure for measuring load factor and to determine relationship between load factor, peak hour factor and delay. In this study three locations are considered, volume counts are measured by two methods, one is manual and another is by traffic flow analyzer. A manual counter was used for comparison with the manual volume counts and also to compute peak hour factors. The traffic flow analyzer is used to measure the delay more accurately than with traditional methods with less difficulty and expense. The relation among load factor, constant split ratio and constant flow was calculated from the graph drawn between constant split ratio, constant flow and load factor.

Sosin (1980) has done empirical investigations of delays at some chosen intersections in Poland using time lapse photography technique. The effect of composition of traffic upon delays was also studied and passenger car units estimated using simulation along with the delay observations. The results of the study were compared with the delay models such as Webster and Miller's approach.

Hurdle (1984) presented a paper to serve as a primer for traffic engineers who are familiar with capacity estimation techniques but have not made much use of delay equations. It was noted that the methods available at that time either ignore the way in which the delay vary with the time or try to cope with the variation in ways that are more mathematical application of common sense than mathematical models of traffic signal system. He found that none of the models examined can be expected to give really consistent and accurate results. To obtain such results, one would not need just better models but better information about traffic patterns.

DATA COLLECTION

In order to study the service delay (delay experienced by a vehicle at the reference line), intersections located in city were selected. These intersection sites were in urban areas. But the effect of upstream junctions, on-street parking, or bus stops on arrival rate is negligible. An important traffic feature at all the three intersections was that the queue formation on the minor street approaches was very rare. One of the three intersections is of T-type and the remaining two were four legged.

As a part of delay study, at each intersection, data were collected by video recording technique on a typical weekday. The video camera was placed at a suitable vantage point near the intersection to record an unobstructed view of all approaches and turning movements and data were recorded for about 1hr to 2 hr depending upon the significant sample of vehicle type. The recorded video file was played in the laboratory several times to get the conflicting traffic volume count and the service delay experienced by each subject vehicle. Both crossing and merging types of conflicts were taken into account while noting the conflicting traffic for each maneuver during the data extraction process.

Methodology

Two signalized intersections located in an industrially fast developing city located in Hyderabad, India were chosen for the present study. All of them are four legged isolated type, provided with pre timed signal control operating in four phases with permitted left turns. These study intersections were selected in such a way that they have fair geometry (level gradient on all the approaches) and there is least interference to traffic by pedestrians, bus stops and parked vehicles etc. Average driving behavior was assumed and the condition of vehicles was assumed to be moderate. The traffic is highly heterogeneous in nature with poor observance of lane discipline. The composition of traffic consists of a large proportion of motorized two wheelers, a small percentage of auto rickshaws, cars and very smaller proportion of heavy vehicles. Layout of all the five study intersections showing the geometry.

Analysis of Suchitra Junction Data

- Measurement of Saturation Flow

$$\textit{saturation headway} = \frac{\textit{total saturation green time}}{\textit{no. of vehicles}}$$

$$\textit{Saturation Flow} = \frac{3600}{\textit{Saturation Headway}}$$

- East Bound:

Total saturation green time = 285 sec

No. of vehicles = 561

Saturation headway =(285/561)

= 0.5

Saturation flow= (3600/0.5)

= 7086 veh/hr.

- West Bound

Total saturation green time = 265 sec

No. of vehicles = 457

Saturation headway =(265/457)

= 0.58

Saturation flow = (3600/0.58)

= 6208veh/hr.

- North Bound

Total saturation green time = 275 sec

No. of vehicles = 482

Saturation headway=(275/482)

= 0.571

Saturation flow = (3600/0.571)

= 6304veh/hr.

- South Bound

Total saturation green time = 282 sec

No. of vehicles = 542

Saturation headway =(282/542)

= 0.52

Saturation flow = (3600/0.52)

= 6923veh/hr.

Time-in-Queue Calculation

- East Bound:

Vehicles in Queue for East Bound

No. of cycles	Time interval	No. of vehicles in queue
1	20	94
2	20	96
3	20	98
4	20	112
5	20	108
6	20	98
7	20	105

Total no. of vehicles in queue = $\sum V_{iq}$= 94+96+98+112+108+98+105

= 711

Total vehicles passing through the approach = Vtot = 615

Time-in-queue per vehicle $= \boldsymbol{I_S * \frac{\sum V_{iq}}{V_{tot}} * 0.9}$

Therefore

Time-in-queue =diq= 0.9 x [20 x (711/615)]

=20.8 sec.

No. of vehicles stopped = Vstop = 346

FVS = (346/615) = 0.562

No. of vehicles stopping per lane each cycle $=\frac{Vstop}{Nc .N}$

$=\frac{346}{7 X 2}$

= 24.71

From HCM 2000, correction factor (CF) = +2

Acceleration-deceleration delay = 0.562 X 2

=1.12sec

Therefore control delay = time-in-queue + acceleration-deceleration delay

= 20.8 + 1.12

= 22 sec/veh.

- West Bound

Vehicles in Queue for West Bound

No. of cycles	Time interval	No. of vehicles in queue
1	20	75
2	20	76
3	20	78
4	20	77
5	20	69
6	20	83
7	20	74

Total no. of vehicles in queue = $\sum V_{iq}$ = 75+7678+77+69+83+74

= 532

Total vehicles passing through the approach = Vtot = 506

Time-in-queue per vehicle =$I_S * \frac{\sum V_{iq}}{V_{tot}} * 0.9$

Therefore

Time-in-queue =diq= 0.9 x [20 x (532/506)]
=18.91 sec.

No. of vehicles stopped = Vstop = 296

FVS = (296/506) = 0.585

No. of vehicles stopping per lane each cycle =$\frac{Vstop}{Nc .N}$

=$\frac{296}{7 X 2}$

= 21.14

From HCM 2000, correction factor (CF) = +2

Acceleration-deceleration delay = 0.585 X 2

=1.2sec

Therefore control delay = time-in-queue + acceleration-deceleration delay

= 18.91 + 1.2

= 20.07 sec/veh.

Conclusions

From analysis of results and observation of traffic characteristics the following conclusions are drawn.

- Following the above mentioned criteria study intersection 1 i.e., Suchitra Junction has an aggregate delay of 21.2 sec/veh.
- Based on the aggregate delay the Level of Service at the intersection 1 i.e., Suchitra Junction is LOS “C”.
- Following the above mentioned criteria study intersection 2 i.e., Kukatpally Junction has an aggregate delay of 35.62 sec/veh.
- Based on the aggregate delay the Level of Service at the intersection 2 i.e., Kukatpally Junction is LOS “D”.

Scope for Further Work

For better understanding of the methodology, the data should be considered from morning to evening. The acceleration and deceleration delay can be measured directly from the field. By using HCM methodology in this present study reliable results are obtained. Besides HCM methodology, other delay models should also be modified under the heterogeneous road traffic condition to estimate delays for oversaturated conditions. Moreover by considering the variability of delay, more reliable signal control strategies may be generated resulting inimproved level of service.

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