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Estimation of Capacity at Un-Signalized Intersections under Mixed Traffic Flow Conditions

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ABSTRACT : *The methodology for the analysis of unsignalized intersections has been established where identical traffic conditions are depending upon the present traffic scenario. There are several attempts made to develop different approaches for the analysis of unsignalized intersections under Mixed, Major and Minor traffic conditions. Conflict technique is a recent development, which is based on practically simplified concept, considering interaction and impact between flows at intersection and using different mathematical models by calibrating their accuracy. In present study, capacity of unsignalized intersection was calculated from Conflict technique. Surveys were conducted in Visakhapatnam, to measure different traffic parameters Volume, Flow and Capacity to this method. Movement capacities were evaluated by using HCM (2000) for comparison with approach wise capacities obtained from conflict technique from different directions on the study area.*

KEYWORDS: *Capacity, Conflict technique, Surveys, Tanner Model, Traffic Parameters, Unsignalized Intersection*

I. INTRODUCTION

The rapid development in India has brought an increase to the cost of living of the citizen. It influenced the travel pattern of the community from their origin to any destination. The development also affects the transportation system as shown by the annual increase in the No. of vehicles on Roads. In India carry different types of vehicles like high speed automobiles, low speed cycles, cycle rickshaws and animal drawn carts. This will lead to complex interaction between the vehicles and study of such traffic behavior needs special attention. This will result in increased interactions between vehicles; then they tend to move in clusters rather than one after the other.

Traffic consists on Indian roads of bi-directional freedom traffic such as two or three wheeled vehicles and uni-directional vehicles such as four wheelers. While the above tend to overtake or turning or crossing or turn right even if a small gap is available. Hence, to determine the intersection capacity traffic engineer requires a clear understanding of gaps being accepted or rejected by various modes of traffic. Besides, in these mixed traffic conditions, users do not usually follow lane discipline and can occupy any lateral position on the road. To prevent traffic accidents, conflicting traffic streams are separated either in space or in time.

There are several types of capacity analysis models for unsignalized T-intersections. Capacity at unsignalized intersection is measured with two methods. First approach consists of Gap Acceptance Procedure (GAP). Second approach consists of Empirical Regression method. GAP method mostly used in United states and European Countries which is based on Critical-Gap acceptance and Follow-up times of vehicles from the minor road. By the Collection of field data and Estimation of Capacity of Minor movements and measures of traffic performance at approaches to Urban major/minor priority junctions. Third approach is the conflict technique with pragmatically simplified concept where the interaction and impact between flows/streams from each approaches of intersection was based on the mathematical formulation.

II. OBJECTIVE AND SCOPE OF PRESENT STUDY

[1] To study the different traffic parameters for conflict technique by using HCM method.
[2] To identify the traffic conflicts in a Major & Minor Streams in a particular intersection or junction.
[3] To know the priorities an intersection/junction by using Mathematical Model.

III. AREA OF STUDY

The major traffic conflicts occur in T-Intersections is identified by Visakhapatnam are:
[1] Urvasi Junction
[2] Kancharpalem Junction
[3] Gnanapuram Junction

IV. DATA COLLECTION AND ANALYSIS

The study of traffic behaviour is useful for traffic engineers to design intersections, for developing traffic control warrants, traffic signal timings, to design the vehicle storage lanes. Data is needed for analysis and understanding of the traffic conditions. The data can be collected by manual method.

This method employs a field team to record traffic volume on the prescribed record sheets. By this method it is possible to obtain data which cannot be collected by mechanical counters, such as vehicle classification, turning movements and counts where the loading conditions or No. of occupants are required. By selecting typical short count periods, the traffic volume study is made by manual counting. Manual counts are typically used for periods of less than a day. Normal intervals for a manual count are 5, 10, or 15 minutes. Then by statistical analysis the peak hourly traffic volumes as well as the average daily traffic volumes are calculated. This method is very commonly adopted due to specific advantages over other methods.

The main objective of this study is to find the capacity of unsignalized intersection using conflict technique and to compare the results with the HCM (2000) procedure, which is based on the gap acceptance procedure. For this the following field observations are necessary.

[1] Travelled distance for each movement on each approach.
[2] Times of arrival and departure at reference lines for each vehicle from each stream.
[3] Approach speed of the vehicles.
[4] Volume at unsignalized intersection movement-wise.

Manual Counts are typically used where,

- Small data samples are required
- Automatic equipment is not available, or the effort and expense of using automated equipment are not justified
- The count period is less than a day

Manual counts are typically used to gather data about the following:

- Turning movements
- Direction of move
- Pedestrian actions

The number of people need to collect data depends on the length of the count period, type of data being collected, number of lanes or cross walks being observed, and traffic volume.

Volume Count Study : To determine the number, movement and classification of roadway vehicles at a given location. The number of observers needed to count the vehicles depends upon the number of lanes in the highway on which the count is to be taken and the type of information desired. The indications in table can be used as rough guides. It is perhaps more desirable to record traffic in each of travel separately and past separate observer for each direction enumerators should be literate persons with preferably middle or matriculation level for the purpose.

Gap Acceptance Study : Pedestrians preparing to cross the roadway must access the gaps in conflicting traffic determine whether sufficient length is available for crossing & decide to cross the road. Following experiments presents a method for collecting field data to identify the minimum usable gap. As if any traffic engineering analysis recognition & definition of the difference between the standard values of the observed values & the observed values increase the accuracy.

Gap Acceptance Capacity Model : This method is based on critical gap acceptance and follow up times of vehicles from the minor road**.** The theory of gap-acceptance is the major concept for unsignalized intersection analysis. The modified Tanner's formula was found to be the most suitable model.Tanner proposed a theoretical model to relate the various parameters connected with the delay problem in dealing with an Intersection of a Major and Minor road and for finding capacity at unsignalized intersections and the expression is as follows:

$$C_p = \frac{q_M(1-\lambda t_p)e^{-\lambda(t_c-t_p)}}{1-e^{-\lambda t_f}}$$

Where,
$\lambda = q_M/3600$ (veh/s)
t_p=minimum headway in the major traffic stream
t_c= critical gap
q_M= number of major stream headway
t_f = follow-up gap respectively

Tables & Figures : Table (1) and Figure (3) shows the maximum number of vehicles in the peak hours is 200 in the direction from Minor Street to Right side in the morning hours and away from complex in the major street in the evening hours.Table (2) and Figure (5) shows the maximum number of vehicles in the peak hours is 212 in the direction from Minor Street to Left side which is obtained in the evening hours.
Table (3) and Figure (7) shows the maximum number of vehicles in the peak hours is 211 in the direction from Minor Street to Right side which is obtained in the evening hours.

V. CONCLUSIONS & RECOMMENDATIONS

[1] The data like Volume, Flow, and Capacity of each type of vehicle can be obtained from the field study where as for gap acceptance models.
[2] Based on the traffic flow measurements, the maximum flow of a stream, the total capacity of an intersection can be calculated.
[3] By Comparing all the 3 T-intersections
[1] The study area of Kancharpalem Junction has shown the Mixed traffic conditions.
[2] The maximum number of vehicles in the peak hours is 212 in the direction from Minor Street to left side which is obtained in the evening hours.
[3] The study area of Gnanapuram Junction has shown the Major Stream.
[4] The maximum number of vehicles in the peak hours is 211 in the direction from Minor Street to right side which is obtained in the evening hours.
[5] The study area of Urvasi Junction has shown the Minor Stream.
[6] The maximum number of vehicles in the peak hours is 200 in the direction from Minor Street to right side in the morning hours and away from complex in the Major street in the evening hours.

[1] The signal should be provide at Kancharpalem and Gnanapuram Junctions.
[2] Critical gap, follow-up time (tc, tf) are Calculated by 3 Junctions within the limit of HCM (2000).
[3] The conflict approach is suitable to calculate the capacity of unsignalized intersections under mixed traffic flow, especially for India as an alternative instead of using the Highway Capacity Manual (2000).

VI. SCPOE FOR FURTHER STUDY

The present work can be extended as indicated below

[1] Pedestrians are not considered in this study, further study can be focused on pedestrian movements along with vehicle movements.
[2] It was recommended to extend the study for more than two hours and the speed can be counted in order to achieve a better prediction.

The equation used for T-junctions and the same can also be used for four-legged intersections which gives more accuracy in data analysis.

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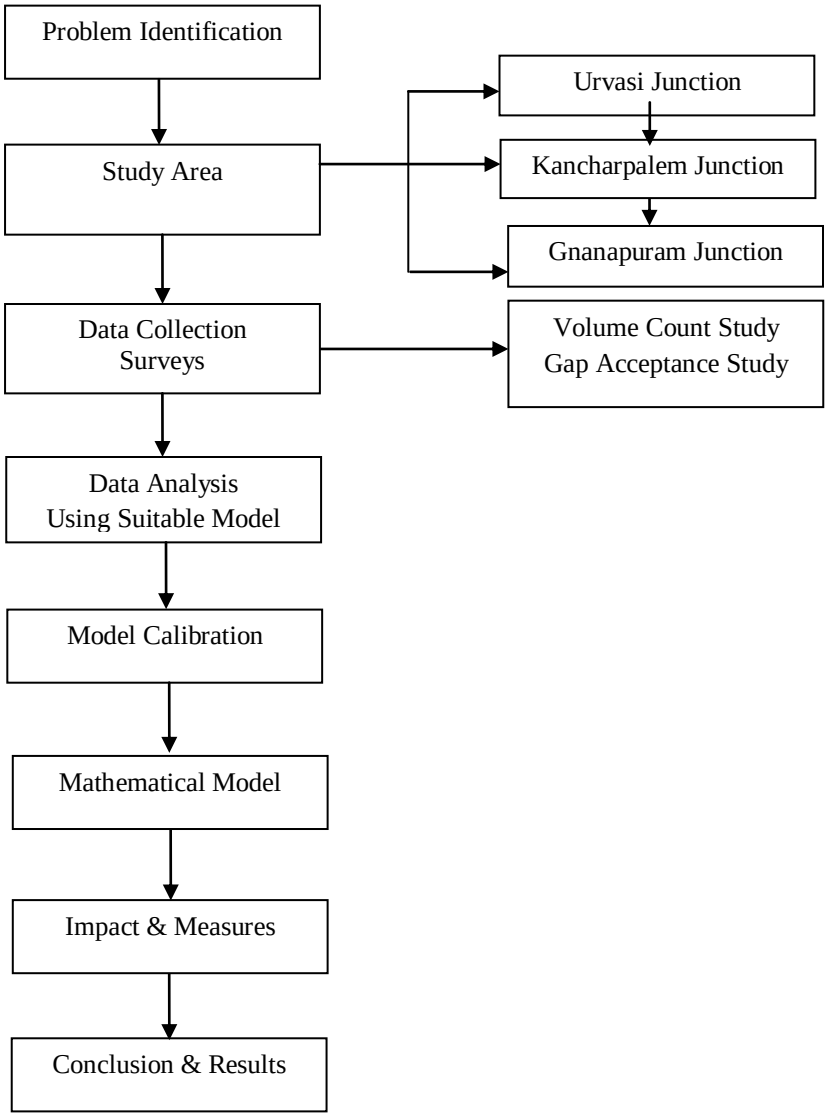

Figure-1 Methodology

(a) (b)

Figure-(a) & (b) Author collecting the traffic data in the study area

Hourly Variations of Traffic in the Study Areas

Table: 1 Comparison of the Peak Hour Traffic Variations at URVASI JUNCTION

Name of the Junction	Conflict	Maximum No. of Vehicles		Maximum values of capacity	
		Morning	Evening	Morning	Evening
Urvasi	Towards Complex	190	189	22.8	58.07
	Left side	182	191	30.6	53.07
	from Complex	187	200	20.49	48.29
	Right side	200	189	20.79	51.8

Figure-2 Site View of Urvasi Junction

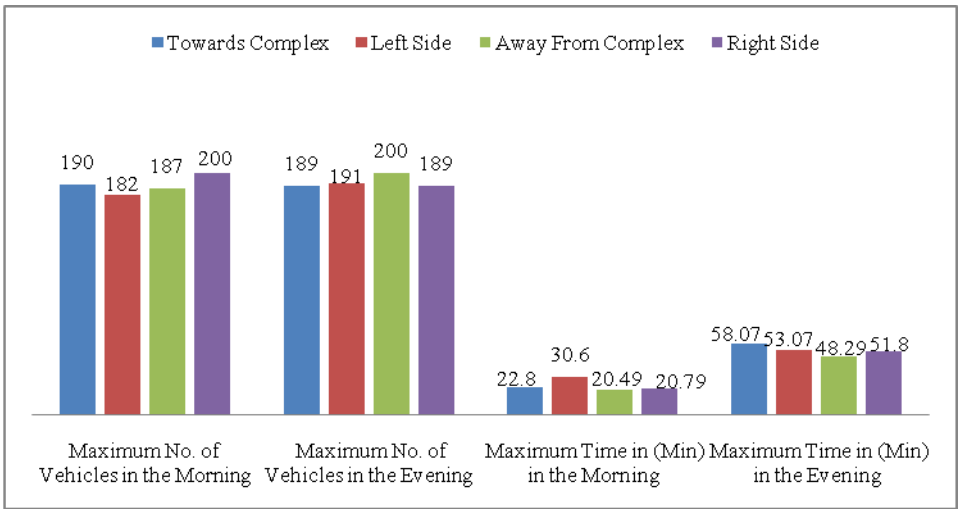

Figure-3

Table: 2 Comparison of the Peak Hour Traffic Variations at KANCHARPALEM Junction

Name of the Junction	Conflict	Maximum No. of Vehicles		Maximum values of capacity	
		Morning	Evening	Morning	Evening
Kancharpalem	Towards Convent	205	196	58.18	33.63
	Left side	197	212	32	31.57
	Away from Convent	191	209	52.98	44.62
	Right side	199	207	58.07	37.23

Figure-4 Site View of Kancharpalem Junction

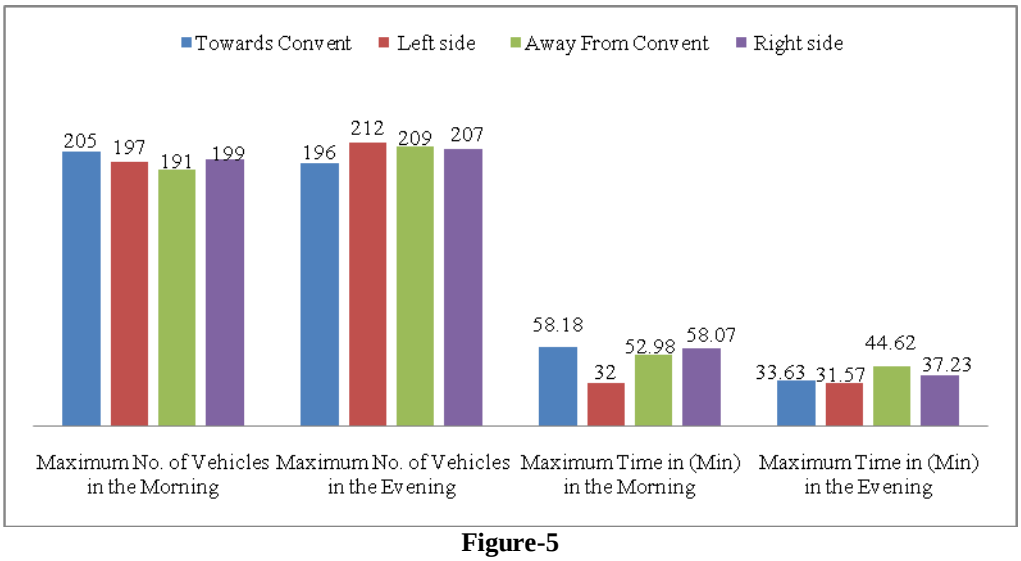

Figure-5

Table: 3 Comparison of the Peak Hour Traffic Variations at GNANAPURAM Junction

Name of the Junction	Conflict	Maximum No. of Vehicles		Maximum values of capacity	
		Morning	Evening	Morning	Evening
Gnanapuram	Towards Dondaparthy	206	196	45.67	57.8
	Left side	206	204	54.03	58.75
	Away from Complex	206	211	29.88	48.1
	Right side	203	198	48.64	60.14

Figure-6 Site View of Gnanapuram Junction

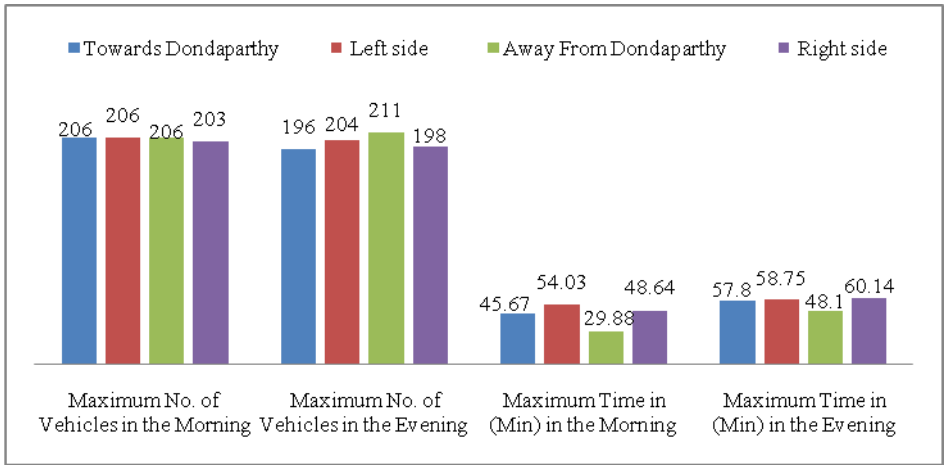

Figure-7

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