CAPACITY ANALYSIS OF UN-SIGNALIZED T-INTERSECTION - A CASE STUDY OF VADODARA

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Abstract : The method for the Capacity evaluation of un-signalized intersections has been recognized where equal traffic situation is depending upon the present traffic scenario. Typical cities in developing countries performed by the heterogeneous traffic mixed including fast–moving vehicles and slow-moving vehicles. Traffic rules for examples like give-way or lane discipline are neglected in most cases. The study focused on three–leg un-signalized intersections. The aim of this study is to calculate the capacity of the un-signalized intersection. Surveys will be conducted at two un-signalized T- Intersection which are Motinagar un-signalized T-Intersection and Harni - Warasiya Ring Road un-signalized T-Intersection, Vadodara. In this study, the capacity of un-signalized intersection is calculated from conflict technique.

IndexTerms **- Capacity, Conflict Technique, Un-Signalized T- Intersection, Traffic Parameters.**

I. INTRODUCTION

Capacity

The highest traffic flow existing on a given roadway using all available lanes, it's called capacity of road. The capacity of the road is usually expressed in vehicles per hour. For multi lane highway it is 2000pcph (passenger car per hour), and for 2-lane highway is 2800pcph.

Capacity-related definition

1. Speed
   Speed is the rate of motion of individual vehicles of a traffic stream. It is calculated in m/s, either more generally as kilometers per hour.
2. Time Mean Speed
   The standard speed of various vehicles measured at particular section of the road is called time mean speed.
3. Space Mean Speed
   It is the speed of vehicles on a road length measured at different sections but at the same time.
4. Traffic volume
   The quantity of vehicles crosses a section of roadway per unit period at any chosen period is called traffic volume.
5. Density
   Density is the amounts of vehicle occupy a part length of roadway at particular period. The unit length is usually one kilometer. When vehicle is in a jammed situation, the density is greatest. It is known as the jamming density.

An intersection is a node and the capacity of intersection affects the total capacity of highway network due to all types of turning movement. The traffic on Indian roads consists of different classes of vehicles such as cars, buses, trucks, auto rickshaws, scooters, cycles, etc. The gap acceptance method is to determine the capacity at un-signalized intersection. It depends on the driver's decision to take the right opportunity to enter the major street. This behavior is defined as gap acceptance. In this case, the driver in the minor street will wait for an adequate gap before entering the major street.

When two or more roads are crossed to each other t`he traffic conflicts are created. Such conflicts may cause delay and traffic congestion with the chances of road accidents. Thus, each intersection requires traffic control. It is regulated with stop signs, traffic lights, and roundabout. Due to intersection of several movements that passes through the same area by intersecting each other so the vehicle belonging this conflict have to pass one after other. A set of movements involved in particular conflict is called conflict group.

II. OBJECTIVES OF THE STUDY

- Consider the traffic performance at un-signalized intersections under mixed traffic condition, e.g. Flow and Geometric condition of the intersection.
- To find out the capacity of un-signalized intersection using conflict method.

III. STUDY AREA

Intersection-1: (Motinagar un-signalized T-intersection) Warasiya Ring Road, Motinagar, Kishanwadi is a Locality in Vadodara City in Gujarat State, India. There is T- Intersection at Motinagar. There are 2 major roads and 1 minor road. One major road is connected to Uma Circle and another major road is connected to the Sangam crossroad and a minor road is connected to khodiyar Nagar circle, New VIP Road. There are 1 Petrol Pump, 1 Hospital, 1 Temple, and so many commercial hubs. For dealing with this broad area more surveyors required to collect the data at the given time. Three types of data collection survey are carried out are,

- Volume Survey
- Turning Moments
- Road Geometry

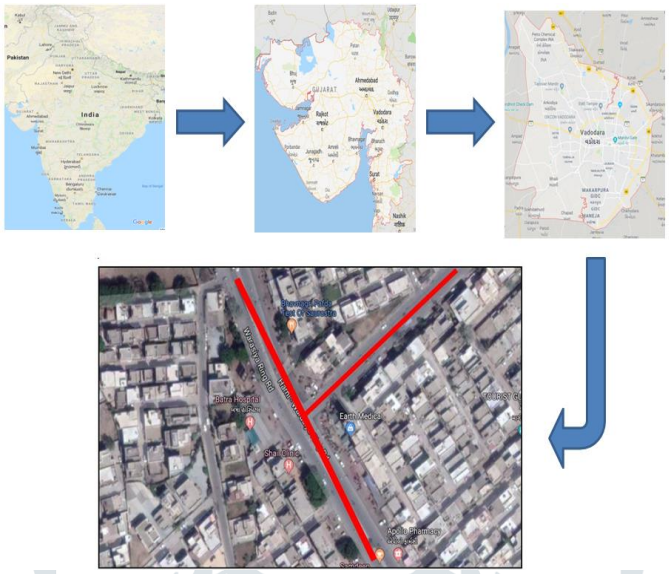

Figure 1-Location of Motinagar un-signalized T-intersection

Intersection-2: (Harni-Warasiya Ring Road un-signalized T-Intersection) Harni-Warasiya Ring Road is a Locality in Vadodara City in Gujarat State, India. There is T- Intersection at Harni-Warasiya Ring Road. There are 2 major roads and 1 minor road. One major road is connected to Uma Circle and another major road is connected to the Sangam crossroad and minor road is connected to RTO Road. There are 2 Hospital, 1 Temple, and so many commercial hubs. For dealing with this broad area more surveyors required to collect the data at the given time. Three types of data collection survey are carried out are,

- Volume Survey
- Turning Moments
- Road Geometry

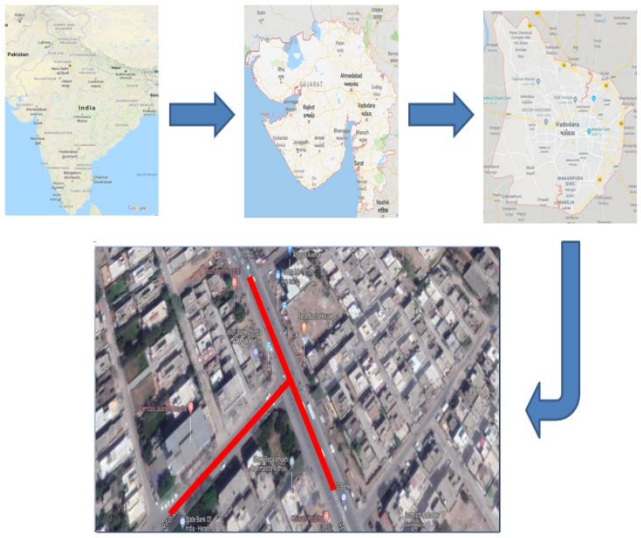

Figure 2-Location of Harni-Warasiya Ring Road un-signalized T-Intersection

IV. METHODOLOGY

In this study to find capacity of two un-Signalized T-intersections has been selected. To achieve the above objectives following steps are involved.

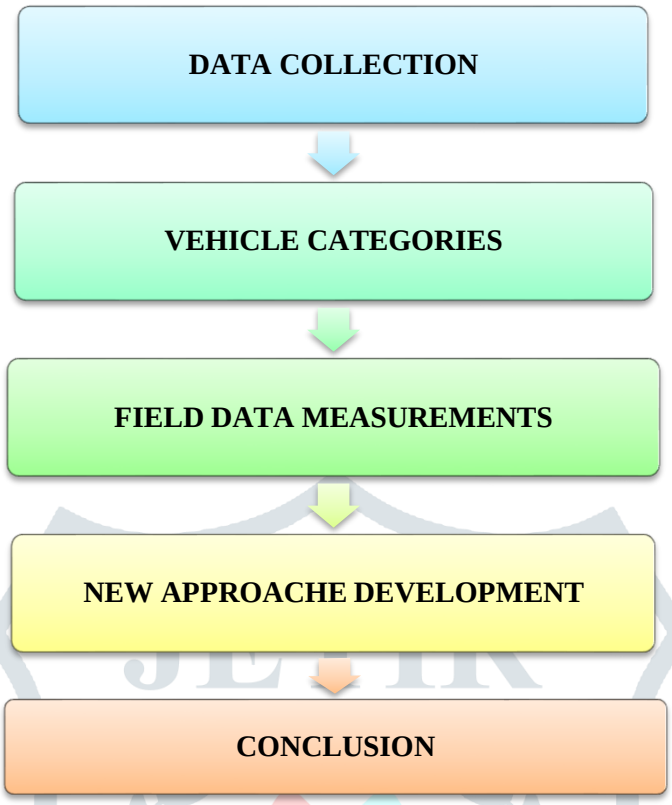

Figure 3-.Flow chart depicting process for determination of capacity

V. DATA COLLECTION

Traffic volume study is conducted to conclude the numbers, movements, and classified roadway at a given space. These much data could help for recognize critical flow time period. The interval of the sampling time depended on the way of count has been taken. In field investigations, the data include traffic flow, road environment, geometric design of the intersections, road side behaviour, etc. at major and minor road will be consider at the given intersections. These features will be recorded by video graphic technique. Each intersection will be investigated during peak hour. The location of the camera will be chosen in such a way that traffic on the road can be practical clearly. The traffic on Indian road consists of different class of vehicle such as car, bus, truck, auto rickshaw, scooter, cycle, etc. Due to the existence of mixed traffic, it is required to categorize vehicle for capacity evaluation.

Time interval

Data collection for daily working hour at the study area can give brief report about the capacity related analysis. So volume and speed study taken for daily working hour at 9.30 to 11.30 for morning peak hour and 5.30 to 7.30 for evening peak hour which give whole idea about volume and speed survey at study area. Data collection at the 60 min interval is more perfect for volume and speed survey.

Timing for volume and speed survey:
For morning peak hour – 9.30 to 11.30
For evening peak hour – 5.30 to 7.30

New Approach Development

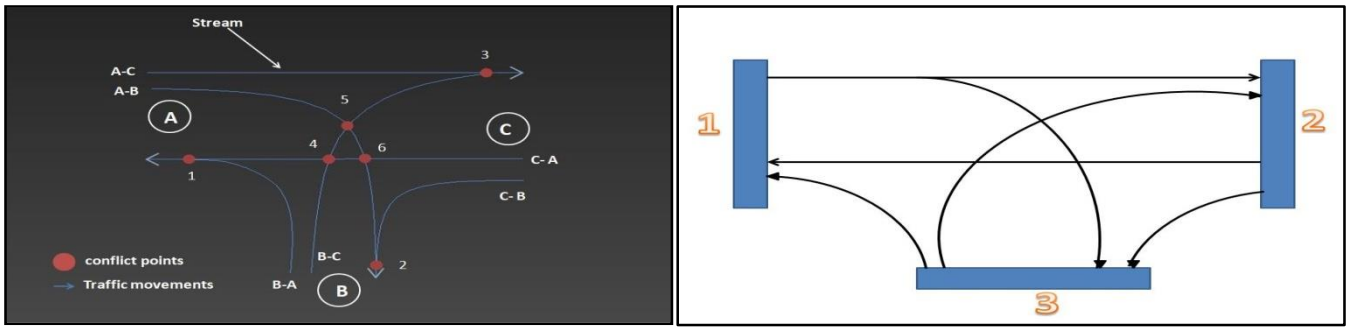

Figure 4-Scheme of conflict of traffic streams at T-Intersection

The parameters of each stream should be analyzed considering the effect of other streams. The scheme consist of six streams (A-C, A–B, B–A, B–C, C–A, C–B) and six conflict points (1, 2, 3, 4, 5, 6).and also, it is proposed to have six groups of conflicts (I, II, III, IV, V, and VI) which include all streams conflicts. For the study, it is necessary to consider the traffic flow count for each of the six streams at intersections. Therefore, the scheme of three–leg un-signalized intersections will be constructed for simplification. Leg A and leg C will be treated as the major roads and leg B as the minor roads.

Table 1-Interactions of Traffic Streams for Each Conflict Group

Group of Conflict	Subject Stream	Conflict Point	Streams Involved
I	A-C	3	A-C, B-C
II	A-B	5,6,2	A-B,B-C,C-A,C-B
III	B-A	1	B-A,C-A
IV	B-C	4,5,3	B-C,C-A,A-B,A-C
V	C-A	6,4,1	C-A,A-B,B-C,B-A
VI	C-B	2	C-B,A-B

VI. DATA ANALYSIS

Data Collected by the volume survey is categorize day wise. All data was categorized individually according to interval.

- Classified volume with day wise at peak hour.
- Classified volume with each interval at peak hour.
- To analysis the capacity by using conflict method.

Calculation of Conflicting Traffic Flow

Table 2-Calculation of Conflicting Traffic Flow

Rank	Movement	Conflicting flow (per hour)	
		Two lane	Four lane
1	V_2 V_3 V_5 V_6	-	-
2	**V_1** V_4	$1.5V_5+V_6+V_7$ $1.5V_2+V_3+V_{10}$	**V_5** V_2
3	**V_7** V_{10}	$V_4+V_5+V_1+V_2$ $V_1+V_2+V_4+V_5$	**$V_4+V_5+V_1+0.5V_2$** $V_1+V_2+V_4+0.5V_5$
4	V_8 V_{11}	$V_4+V5+V1+V_2+V_3+V_{10}$ $V_1+V_2+V_4+V_5+V6+V7$	$V_4+V_5+V_1+V_2+V_{10}$ $V_1+V_2+V_4+V_5+V_7$

Calculation of Conflicting Traffic Flow at Motinagar

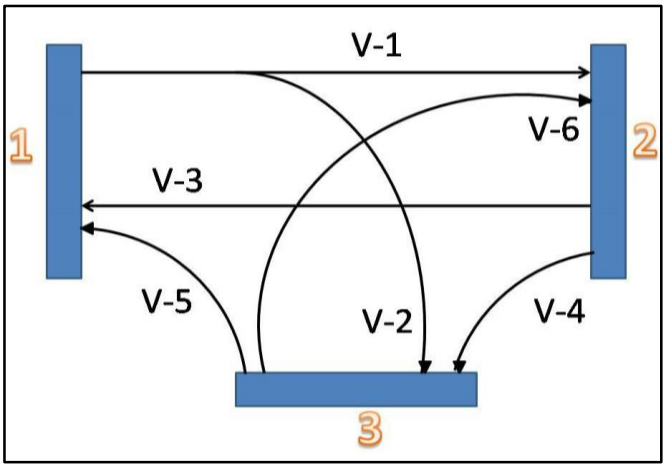

Figure 5-Conflicting Traffic movement at Motinagar

Table 3-conflicting flow equation at motinagar

Movements	Conflicting Flow Equation
Movements-2	V_3
Movements-6	$V_3+V_2+0.5\ V_1$

When to find the capacity by the conflict method where only considered right turning movements. In this study, only movement-2 and movement-6 are considered at Motinagar. Where v=total volume in PCU/hr.

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Table 4-Calculation of Conflicting Traffic Flow at Motinagar

Day	Movements	Conflicting Flow (PCU/hr)
1	Movements-2	4801
	Movements-6	8883
2	Movements-2	4702
	Movements-6	8922
3	Movements-2	4958
	Movements-6	8552
4	Movements-2	3348
	Movements-6	5685

Capacity Calculation at Motinagar

$$C_x = a \times V_{c,x} \frac{e^{-V_{c,x}(t_{c,x}-b)/3600}}{1 - e^{-V_{c,x}t_{f,x}/3600}}$$

Where,

C_x = capacity of movement 'X' (PCU/hr)
V_{cx} = conflicting flow rate corresponding to movement 'X' (PCU/hr)
t_{cx} = critical gap of standard passenger cars for movement 'X' (sec) by HCM
t_{fx} = follow up time for movement 'X' (sec) by HCM
a and b = adjustment factors based on intersection geometry by HCM

Table 5-capacity calculation at motinagar

Day	Movements	Capacity (PCU/hr)
1	Movements-2	208
	Movements-6	5
2	Movements-2	221
	Movements-6	4
3	Movements-2	197
	Movements-6	6
4	Movements-2	393
	Movements-6	44

Level of Service (LOS) at Motinagar

The level of service (LOS) for movement – 2: volume / capacity = 672 / 393 = 1.70 >1.00
The level of service (LOS) for movement – 6: volume / capacity = 1034 /44 = 23.5 >1.00
This implies that the above movement is overloaded and operating at LOS F. It requires the geometric improvements at the intersection.

Calculation of Conflicting Traffic Flow at Harni-Warasiya Ring Road

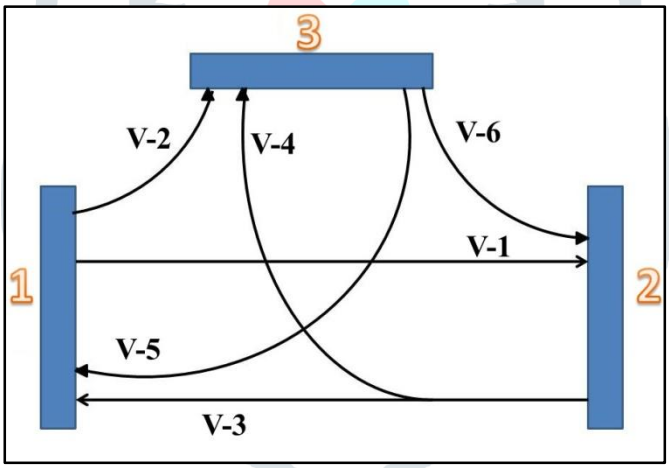

Figure 6-Conflicting Traffic movement at Harni-Warasiya Ring Road

Table 6-conflicting flow equation at Harni-Warasiya Ring Road

Movements	Conflicting Flow Equation
Movements-4	V_1
Movements-5	$V_1+V_4+0.5\ V_3$

Calculation of Conflicting Traffic Flow at Harni-Warasiya Ring Road (day wise)

Table 7- Calculation of Conflicting Traffic Flow at Harni-Warasiya Ring Road

Day	Movements	Conflicting Flow (PCU/hr)
1	Movements-4	4739
	Movements-5	8997
2	Movements-4	4223
	Movements-5	8984
3	Movements-4	2439
	Movements-5	5629
4	Movements-4	5013
	Movements-5	9510

Capacity Calculation at Harni-Warasiya Ring Road

Table 8-Capacity calculation at Harni-Warasiya Ring Road

Day	Movements	capacity (PCU/hr)
1	Movements-4	218
	Movements-5	4
2	Movements-4	273
	Movements-5	4
3	Movements-4	570
	Movements-5	45
4	Movements-4	192
	Movements-5	3

Level of Service (LOS) at Harni-Warasiya Ring Road

The level of service (LOS) for movement – 4: volume / capacity = 1329 / 570 = 2.15 >1.00
The level of service (LOS) for movement – 5: volume / capacity = 817 /45 = 18.15 >1.00
This implies that the above movement is overloaded and operating at LOS F. It requires the geometric improvements at the intersection.

RESULTS & CONCLUSIONS

Results

AS per the conflict method, the capacity of Motinagar Un-Signalized T-Intersection, for movement – 2 is 393 (PCU/hr) and for movement – 6 is 44 (PCU/hr).Similarly the capacity of Harni-Warasiya Ring Road un-signalized T-Intersection, for movement – 4 is 570 (PCU/hr) and for movement – 5 is 45 (PCU/hr).According to these capacity to find out the level of service.

Table 9- Results of Level Of Service (LOS)

Movements	Volume (PCU/hr)	Capacity (PCU/hr)	Volume/Capacity	Level of service (LOS)
At Motinagar				
Movement-2	672	393	1.70	F
Movement-6	1034	44	23.5	F
At Harni-Warasiya Ring Road				
Movement-4	1329	570	2.15	F
Movement-5	817	45	18.15	F

Conclusions

As per the study the capacity of Motinagar Un-Signalized T-Intersection, for movement – 2 is 393 (PCU/hr) and for movement – 6 is 44 (PCU/hr).Similarly the capacity of Harni-Warasiya Ring Road un-signalized T-Intersection, for movement – 4 is 570 (PCU/hr) and for movement – 5 is 45 (PCU/hr).
Hence as per the above results, it is serving the level of service (LOS) is F. so the road is not sufficient of the existing traffic flow. It requires the geometric improvements at the both intersection.

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