CAPACITY AND CRITICAL GAP ANALYSIS IN UN-SIGNALIZED INTERSECTION UNDER MIXED TRAFFIC CONDITION

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ABSTRACT

In this paper, a brief practical review is present done Right-turns have been consider among the most hazardous locations on highways. The maneuvering of the driver at these locations is quite complex and risky. The behaviour of the driver when turning is governed by the gap acceptance concept. In this study, the driver's gap acceptance behaviour at Intersection median openings was studied. Intersection median openings in City were investigated. Data was collected by video/manual recording. Two models were developed in this study:

1. The first model estimated the time gap accepted by the driver.
2. The second model calculated the turning function, which was used to estimate the probability of accepting gaps.

Results showed that male drivers tended to accept shorter gaps than female drivers. Also, younger drivers were more likely to accept shorter gaps than older ones. The waiting time was also found to affect the gap acceptance behaviour of the drivers. Drivers tended to accept shorter gaps after longer waiting times. Establishment of un-signalized median openings has expanded in numerous urban districts of cities in India.

A new method of capacity analysis at un-signalized intersections has been developed in this study for India where the driver's behaviour, traffic composition, level of roadside activities is different from those in developed countries. Typical cities in developing countries performed by the heterogeneous traffic mixed including fast–moving vehicles (motorized) and slow– moving vehicles (un-motorized). The study focused on ten three–leg un-signalized intersections in India. The new method was based on the interactions between conflict streams having the average speed and flow of each stream. All possible conflict streams were considered simultaneously and the interactions were taken into account through empirical regression models. The results of capacity analysis from this proposed method correspond properly with the results from the current Highway Capacity Manual (HCM).

Key Words: U-turns, Time gap, HCM, Un-signalised, Median.

INTRODUCTION

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 intime.

An intersection is a node, and usually it is a block of traffic flow in high way network. Capacity of a intersection affects the total capacity of highway network due to all types of turning movements. Urban 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. Hence, to determine the intersection capacity traffic engineer requires a clear understanding of gaps being accepted or rejected by various modes oftraffic.

During the past two decades, more and more state departments of transportation and local transportationagencieshavestartedinstallingnon-traversablemediansanddirectionalmedian openings on multilane highways. During the past few decades, more and more state departments of transportation came to realize the importance of access management to the modern traffic system and began to use various access management techniques to improvethe traffic operations and safety along major arterials. Many states have developed or are considering developing their statewide comprehensive access management programs one of the major principles of access management is to install non-traverse able medians and directional median openings.

LITERATURE REVIEW

Tupper et al. (2011) studied the factors that influenced the driver's gap acceptance behavior and had clear impact on safety. Different driver's age and gender groups were found to have different gap acceptance behaviors. Factors that had the greatest effect on gap acceptance behavior were found to be the presence of a queue behind the driver, the driver's waiting time and the number of the rejected gaps.

Nabaee et al. (2011) developed and validated a procedure for observing the driver's gap acceptance behavior accurately at two-way left turn lanes (TWLTL) on the major road. Characteristics such as driver's gender, driver's age, vehicle type, presence of a queue behind the leading vehicle and presence of passengers in the vehicle were collected as a function of the time of day (TOD). This work provided updated measures for the accepted gap with the variation of TOD and showed how accepted gaps were related to the waiting time of the vehicle.

Al-Omari and Benekohal (1999) developed the linear waiting time models for unsaturated TWSC intersections by empirical approach. The separate models are also developed for differentturningmovements;right,left,andthrough.Thestatisticaltestunveilsthatthereisno significant differences between the threemodels.

The previous study on u-turn movement shows that the longer time the driver waits at thestop line,the smaller gap the driver accepts. The waiting time of more than 30 seconds will frustrate the drivers to accept the significant smaller gap, which may lead to traffic safety problem (Jenjiwattanakul and Sano,2011).

Zhou and Ivan (2009) studied the gap acceptance behaviour of left turning drivers at six unsignalized intersections. Logit models were used for estimating the probability of accepting a given gap. Results showed that the number of lanes on the major road, the presence of left turn lane sand the gender of the driver explained the variation in the gap acceptance probability. It was also found that older drivers generally tended to accept longer gaps.

Yan et al. (2007) studied the effect of major traffic speed and driver's age and gender on the gap acceptance behaviour of the driver at stop-controlled intersections. Results showed that older drivers, especially older female ones, exhibited the most conservative driving behaviour.

OBJECTIVES

- To study the peak hour volume in the selected intersections
- To evaluate and compare the capacity of the selected un-signalized intersections by HCM and IRC Methods.
- To identify the traffic conflicts in a Major & Minor Streams in a particular intersection or Junction.

METHODOLOGY:

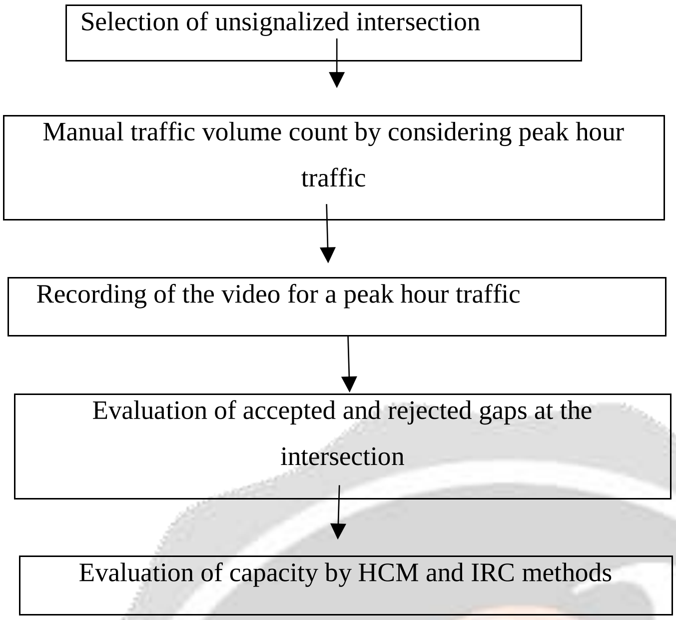


Figure 1: flow diagram of methodology

Selection of the un-signalized intersections.

Data for the present study were collected at 3-legged and 4-legged unsignalised intersections located in different parts of the country. The following points were kept in mind while selecting the site for data collection.

a. A major stream should be clearly identified among the legs of the intersection.

b. The major streams should be free from the effect of upstream junction, parking or bus stop.

c. Mixed traffic conditions of similar kind should prevail all the sites but the pedestrian activities should be minimal.

d. The major street should be free from curvature for at least 200 m in both directions from the intersection.

e. There should be a convenient location for placing the video camera sa as to provide an view of all the approaches and turning movements.

T-intersection selected for the present study.

<u>Sarakki market junction</u>

Figure 2: T-Intersection, Sarakki

Field Data Requirements:

Computations require following types of data inputs to the methodology:

(i) Volume by type of movement for the design hour

(ii) Vehicle classification for the design hour

(iii) Peak hour factor (if peak flow rates are being used as the basis for analysis)

(iv) Prevailing (average running) speed of traffic on the major street

(v) Number of lanes on the major street

(vi) Number of lanes on the minor street approaches

(vii) Other geometric features i.e. channelization, angle of intersection, sight distance, comer radii, Acceleration lanes, etc.

(viii) Type of control on the minor approaches.

ANALYSIS AND RESULTS

Analysis of Intersection:

The following steps describe the procedure of computations:

(i) Hourly volumes are summarized on the top portion of the form on the diagram provided. A 'north 'indication should be inserted to ensure proper orientation of the intersection and of the demand volume.

V, to V6denote movements and on major street and V7to V denote movements on minor street.

(ii) The number of lanes on each approach should be indicated.

(iii) The type of control is indicated by checking the appropriate box, and the prevailing speed on the major street and the Peak Hourly Flow (PHF) be listed.

(iv) Volume adjustments are made to convert Volume Per Hour (VPH) to Passenger Car Per Hour

(PCPH). In general, analysis will be on the basis of full hour volumes. The volumes of all category 1 of vehicles have to be converted into PCPH. Through and left turning volumes on major street would not be converted to PCPH as they are only utilized in computation of 'Conflicting Traffic Volumes which is done in terms of VPH.

(v) The conversion from VPH to PCPH is made using the passenger car equivalent values as given inTable 1. Also, find the total volume (PCPH) for all categories.

Table 1. PCU Values for Rural/Urban conditions

Passenger car, tempo, auto-rickshaw and tractor (without trailer)	1.00
Cycle, Motor/Scooter	0.5
Lorry, Bus and Tractor-trailer unit	3.00
Cycle- Rickshaw	1.50
Horse Driven vehicle	4.00
Bullock carts (big)	8.00
Bullock carts (small)	6.00

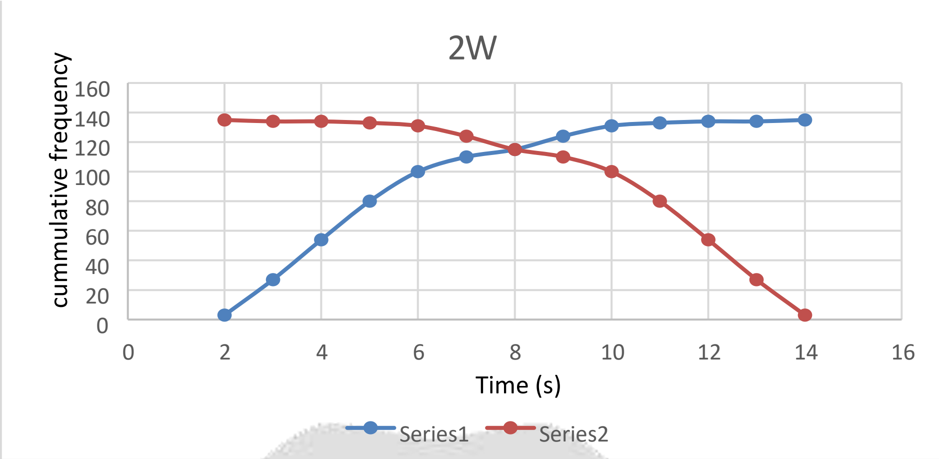
Sarakki market junction:

Banashankari to Kanakpura road:

2W

2 WHEELERS		
Conflicting flow(Vc) vph	135	
Critical Gap(Tc)	8 sec	
Potential Capacity(Cp) pcph : fig. III-2	630	
Percent of Cp utilized in %	(V/Cp) x 100 =	21.43
Impendence Factor(P) : fig. III-4	0.87	
Actual Capacity(Cm) pcph	630	

LOS and Reserve Capacity by IRC Method				
Vpcph	**Actual Capacity(Cm)**	**Shared Capacity(Cm)**	**Reserve Capacity(pcph)**	**LOS**
135	630	630	495	A

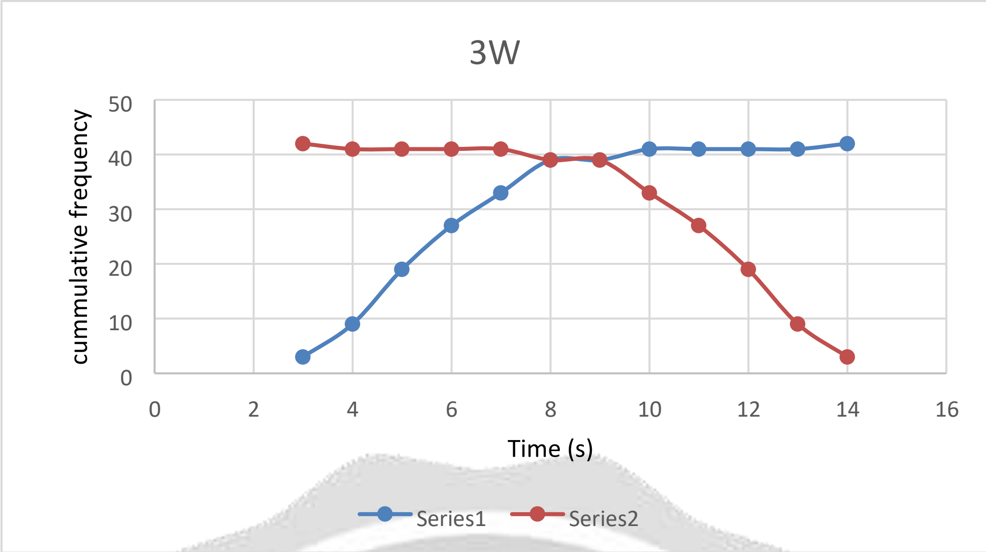


Critical gap accepted is 8s

3W

3 WHEELERS		
Conflicting flow(Vc) vph	42	
Critical Gap(Tc)	9 sec	
Potential Capacity(Cp) pcph : fig. III-2	680	
Percent of Cp utilized in %	(V/Cp) x 100 =	6.18
Impendence Factor(P) : fig. III-4	0.97	
Actual Capacity(Cm) pcph	680	

LOS and Reserve Capacity by IRC Method				
Vpcph	**Actual Capacity(Cm)**	**Shared Capacity(Cm)**	**Reserve Capacity(pcph)**	**LOS**
42	680	680	638	A

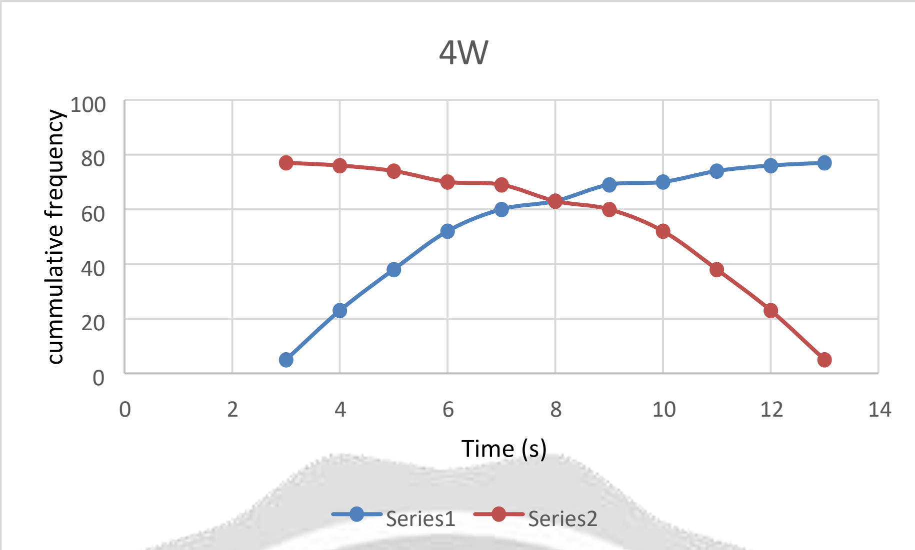


Critical gap accepted is 9s

4W

4 WHEELERS		
Conflicting flow(Vc) vph	77	
Critical Gap(Tc)	8 sec	
Potential Capacity(Cp) pcph : fig. III-2	670	
Percent of Cp utilized in %	(V/Cp) x 100 =	11.49
Impendence Factor(P) : fig. III-4	0.92	
Actual Capacity(Cm) pcph	670	

LOS and Reserve Capacity by IRC Method				
Vpcph	**Actual Capacity(Cm)**	**Shared Capacity(Cm)**	**Reserve Capacity(pcph)**	**LOS**
77	670	670	593	A

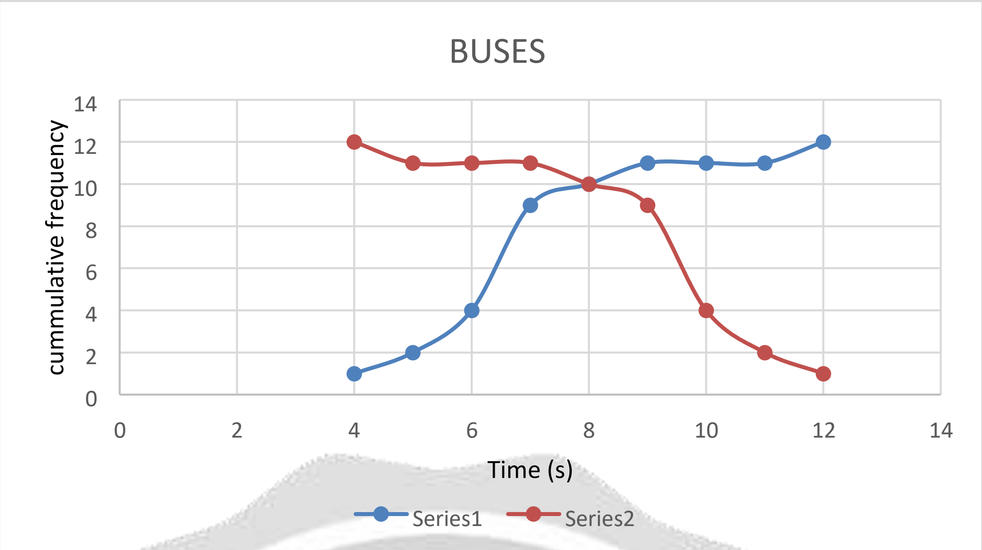


Critical gap accepted is 8s

BUSES

<table>
<tr><th colspan="3">BUSES</th></tr>
<tr><td>Conflicting flow(Vc) vph</td><td>12</td><td rowspan="6">1.67</td></tr>
<tr><td>Critical Gap(Tc)</td><td>8 sec</td></tr>
<tr><td>Potential Capacity(Cp) pcph : fig. III-2</td><td>720</td></tr>
<tr><td>Percent of Cp utilized in %</td><td>(V/Cp) x 100 =</td></tr>
<tr><td>Impendence Factor(P) : fig. III-4</td><td>0.99</td></tr>
<tr><td>Actual Capacity(Cm) pcph</td><td>720</td></tr>
</table>

LOS and Reserve Capacity by IRC Method				
Vpcph	**Actual Capacity(Cm)**	**Shared Capacity(Cm)**	**Reserve Capacity(pcph)**	**LOS**
12	720	720	708	A

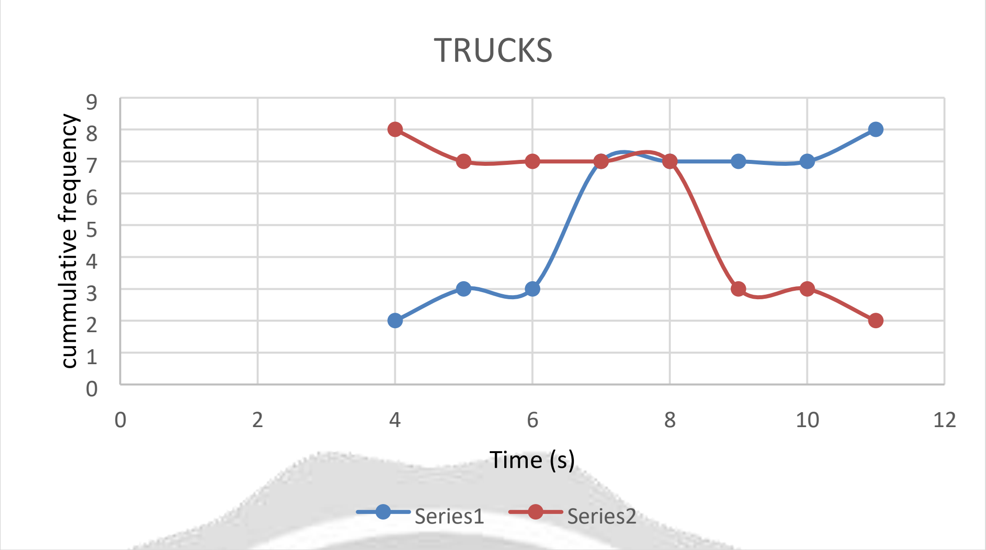


Critical gap accepted is 8s

TRUCKS

TRUCKS		
Conflicting flow(Vc) vph	8	1.10
Critical Gap(Tc)	8 sec	
Potential Capacity(Cp) pcph : fig. III-2	730	
Percent of Cp utilized in %	(V/Cp) x 100 =	
Impendence Factor(P) : fig. III-4	0.99	
Actual Capacity(Cm) pcph	730	

LOS and Reserve Capacity by IRC Method				
Vpcph	**Actual Capacity(Cm)**	**Shared Capacity(Cm)**	**Reserve Capacity(pcph)**	**LOS**
8	730	730	722	A



Critical gap accepted is 8s

CONCLUSION:

The data collected from the three–leg intersections were found valuable in the traffic capacity analysis at unsignalised intersections in developing countries, such as Indonesia.

- Speed and flow measured in 5 minute intervals during one hour observations for each intersection was found appropriate for this analysis in developing the model.
- A model was developed by showing relationship between speed and flow at each intersection. The results showed that there is a good relation between speed and flow for each conflict group. Therefore, the capacity of intersections can be developed based on the relationship between speed and flow of streams at various conflict groups.
- The results obtained by the proposed method were compared with the Indonesian Highway Capacity Manual. The method produced similar values of capacity in the speed range of 11to12km/h hence it can be used for capacity analysis of un-signalized intersections.

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