CAPACITY AND CRITICAL GAP ANALYSISIN IN UNSIGNALISED INTERSECTION UNDER MIXED TRAFFIC CONDITION

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Abstract - *In this paper, a brief practical review is presented on U-turns have been considered among the most hazardous locations on highways. The maneuvering of the driver at these locations is quite complex and risky. The behavior of the driver when turning is governed by the gap acceptance concept. In this study, the driver's gap acceptance behavior at U-turn median openings was studied. U-turn 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 behavior 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.

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

1. 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 in time.

An intersection is a node, and usually it is a block of traffic flow in highway 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 of traffic.

Gap is defined as the time or space headway between two successive vehicles in a particular traffic stream. Gaps are expressed in terms of space when the distance between the fronts of the two vehicles is considered. They are expressed in terms of time when the time elapsed between the arrivals of the vehicles is considered. Gap acceptance is the process through which a driver has to evaluate the gaps and judge whether they are enough or not for merging.

The gap acceptance concept is widely used in the determination of the capacity, delay and level of service at various transportation facilities. It is also used for safety during the past two decades, more and more state departments of transportation and local transportation agencies have started installing non-traversable medians and directional median 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 improve the 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-traversable medians and directional median openings.
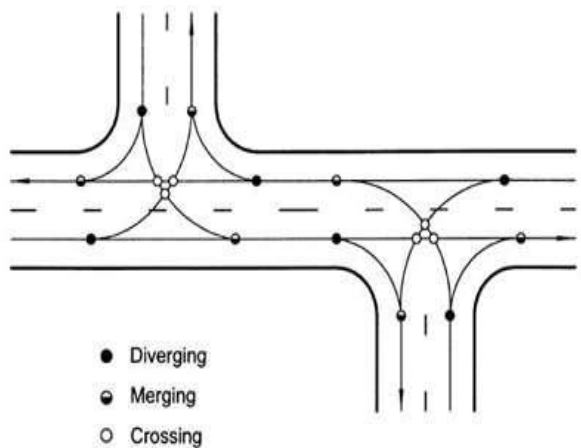

Fig. 1: Conflict Points at a Conventional Full Median Opening Versus a Directional Median Opening.

Fig. 2: Critical Gap of traffic on upstream direction.

Fig. 3: U-Turn traffic on upstream and downstream directions.

2. 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.

Chandra et al. (2009) analyzed the waiting time at uncontrolled intersections in mixed traffic conditions by microscopic approach. The microscopic analysis considers each individual subject vehicle. The conflicting flow rate as seen by the particular subject vehicle is the number of observed conflicting vehicles divided by the observation time. Some advantages of this method are that the data is not lost by aggregation and the data points are increased. It also reflects the real conflicting flow rate the subject vehicle faces when waiting for an acceptable gap. The function of waiting time is in the exponential form.

Madanat et al. (1994) developed the waiting time function by probability theory. The expected waiting time at the stop line is the product of the average size of rejected gaps and the expected number of rejected gaps. The process of rejecting sequential gaps is expressed as a geometric distribution. The gap size is assumed to be negative exponential distributed in their study.

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 different turning movements; right, left, and through. The statistical test unveils that there is no significant differences between the three models.

The previous study on u-turn movement shows that the longer time the driver waits at the stop 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 behavior 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 lanes and 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 behavior of the driver at stop-controlled intersections. Results showed that older drivers, especially older female ones, exhibited the most conservative driving behavior.

3. OBJECTIVES

1. To study the peak hour volume in the selected intersections.

2. To study the accepted and rejected gaps to evaluate the critical gap.

3. To evaluate and compare the capacity of the selected unsignalized intersections by HCM and IRC Methods.

4. To identify the traffic conflicts in a Major & Minor Streams in a particular intersection or Junction.

4. CONCLUSIONS

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

1. 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.
2. 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.
3. 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 11 to 12 km/h; hence it can be used for capacity analysis of unsignalized intersections.

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