

PEDESTRIAN CROSSING BEHAVIOUR ANALYSIS AT INTERSECTIONS

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ABSTRACT

A clear understanding of pedestrian crossing behavior under mixed traffic conditions is needed for providing necessary infrastructure and also for enhancing pedestrian safety at signalized intersections. This paper attempts to analyze the crossing behavior of pedestrians like crossing speed, compliance with signal, and pedestrian-vehicular interaction under mixed traffic conditions and to identifying the influencing factors based on statistical tests. This study can help researchers and practitioners to understand pedestrian crossing behavior at signalized intersections and develop pedestrian delay models under mixed traffic conditions. Pedestrian crossing behavior is analyzed for the provision of proper pedestrian facilities at desired locations as well as to improve their safety while crossing the road. This paper presents the analysis of pedestrian crossing behavior from a study conducted at Pari Chowk intersection in Greater Noida city. The effect of pedestrian characteristics like age, gender and that of carrying baggage and luggage as well as their crossing patterns were examined on pedestrian flow characteristics like crossing speed and waiting time. Pedestrian safety was also analyzed with respect to safety margins and gaps accepted by pedestrian in traffic stream.

Keywords: *Behavior, crossing speed, Interaction, non-compliance, pedestrian, signalized intersection*

1.INTRODUCTION

Traffic accidents involving pedestrians have become a major safety problem all over the world particularly in developing countries due to high population density, rapid urbanization, and lack of adherence to traffic regulations by both drivers and pedestrians. Lack of adherence to traffic regulations at pedestrian crossings particularly by drivers create a paradigm in which pedestrians may become bold and force approaching vehicles in the traffic stream to brake in order to gain priority at the pedestrian crossing. On the other hand, pedestrian crossings with heavy pedestrian flow are likely to cause unacceptable vehicular delay. Pedestrians are observed to be a major component of the total urban traffic accidents. In India, pedestrians account for 65% of the accident deaths and out of these 35% pedestrians are children. Hence, there is a special need to analyze the crossing behavior of pedestrians to ensure their safety on roads. Signal phases have been provided to control the interaction between pedestrians and vehicles at signalized intersections crosswalk where they share the same

road space. Still pedestrian-vehicular interactions occur due to pedestrian non-compliance behavior with traffic signals. Major reasons for pedestrian non-compliance with traffic signals are low quality traffic management, traffic volume and longer cycle time. Apart from these, there are many other factors that affect the pedestrian non-compliance behavior with signals and interactions but have not been taken into account in existing studies. Pedestrian crossing speed is one of the significant design parameters while designing signalized intersection infrastructures in traffic engineering. Indian Road Congress (IRC) estimated walking speed at crosswalks of 1.2 m/s. This constant value is not applicable for dynamic traffic conditions prevailing at signalized intersections. Pedestrian crossing speed varies with regard to the pedestrian characteristics and behavior. To improve pedestrian safety, transportation planners and engineers are predominantly concerned with understanding and modeling pedestrian crossing behavior so as to increase the walkability and also to reduce the interaction between pedestrians and vehicles at signalized intersections under mixed traffic conditions. In the existing studies, majority of the factors that have been neglected about pedestrian crossing behavior more, there has not been a study that has examined pedestrian crossing speed variation and pedestrian-vehicular interaction in crosswalks of signalized intersections with effective factors such as pedestrian characteristics, behavior, and traffic characteristics. This paper examines all possible parameters that influence pedestrian crossing behaviors.

II. RESEARCH OBJECTIVES

The objectives of this study are as follows:

- (a) Examine the effects of pedestrian and traffic characteristics on pedestrian crossing behavior.
- (b) Identify the factors that dominantly affect pedestrian crossing speed in the crosswalks at signalized intersections.
- (c) Determine the most significant factors affecting pedestrian compliance rate and identifying of reasons for pedestrian non-compliance.
- (d) Obtain the factors influencing pedestrian-vehicular interaction in the crosswalks of signalized intersections under mixed traffic conditions.

III. DATA COLLECTION

3.1 IDENTIFICATION OF STUDY LOCATIONS

The locations for carrying out the pedestrian study are decided based on the combination of land uses, width of the road and the type of intersection. Data were collected from the Pari chowk in Greater Noida city.

The study locations chosen for the present study satisfies the following criteria:

- The pedestrian traffic is enough.
- The traffic flow is continuous.
- The effective width of the road is uniform throughout the length considered.

3.2 DATA COLLECTION TECHNIQUE

There are different methods for data collection. These are given below:

- a) Direct observation method
- b) Video observation method
- c) Time Lapse Photography
- d) Pedestrian opinion survey

Out of the above, video graphic method is used in the present study. The camera was fixed in an elevated position so as to obtain an overall view of the selected test locations. Recording was done for about 60 minutes at a time during morning (10.00 am to 12.00 noon) and evening (4.00 pm to 6.00 pm) on a normal working day. The width of the road sections (i.e. perpendicular and oblique) are measured using an instrument called measuring wheel.

IV.METHODOLOGY FOR DATA ANALYSIS

4.1 DATA ANALYSIS

This section presents the relationships plotted between pedestrian crossing time, waiting time, total travel time and cumulative percentage of pedestrians. Based on these relationships, the values of pedestrian characteristics like crossing speed are computed for mixed traffic flow conditions. Variation in pedestrian speeds according to one step or two step crossing, perpendicular and oblique crossings are also analyzed.

4.2 PEDESTRIAN CROSSING BEHAVIOR

4.2.1 CROSSING PATTERNS

During the analysis of recorded data from different study locations, two major crossing patterns are observed which can be classified as (a) one step or two step(b) perpendicular/ oblique crossings. The proportion of pedestrians estimated within these different crossing patterns are shown in Table 1 for all study locations.

Table 1 PEDESTRIANS CROSSING PATTERNS

Crossing Patterns	Percentage of Pedestrians (%)	
	One Step Crossing	Two Step Crossing
Perpendicular Crossing	53.98	7.36
Oblique Crossing	31.90	6.74
Overall	85.89	14.11

4.2.2 CROSSING TIME AND WAITING TIME

After collecting the data from study location using video graphic technique, the analysis of pedestrian crossing speeds with respect to certain pedestrian characteristics is usually desired. For that purpose, firstly the pedestrian crossing time and waiting time is observed from the video of study locations. The crossing and waiting time is

observed for perpendicular and oblique crossing condition separately. The analysis of crossing time and waiting time is done for one step crossing and two steps crossing separately. The analysis presented here uses data of the study location.

Table 2 WAITING TIME AND CROSSING TIME

Location	Crossing Patterns	Perpendicular Crossing		Oblique crossing	
		Waiting time in sec	Crossing time in sec	Waiting time in sec	Crossing time in sec
Overall	One step	1.5(0-3.5)	6.0(5.0-9.0)	1.0(0-3.0)	8.0(5.0-11.0)
	Two step	4.5(2.0-7.0)	7.0(3.0-12.0)	4.5(0-10.0)	9.0(5.5-13.0)

4.2.3 PEDESTRIAN CROSSING SPEED

Average crossing speeds estimated based on crossing times are given in table 3 for study location.

Table 3 PEDESTRIAN AVERAGE CROSSING SPEED AT STUDY LOCATION

Location	Crossing Patterns	Average Pedestrian Crossing Speeds(m/sec)	
		Perpendicular Crossing	Oblique Crossing
Pari chowk	One Step	1.64	1.46
	Two Step	1.52	1.71

4.2.4 GAPS ACCEPTED AND SAFETY MARGINS

Safety margin of a pedestrian is defined as the time taken by the approaching vehicle to reach the point at the other end of the road where the pedestrian ends crossing the road without conflicting it. Time gap is defined as the time taken by the pedestrian so that it starts crossing the road without conflicting the approaching vehicle just coming to start point. The pedestrians having high safety margins and high time gap are more precautious in crossing and they take very less risk. The cumulative curves for time gaps accepted by the pedestrians and for the safety margins of pedestrians are given in Fig. 1 and Fig. 2.

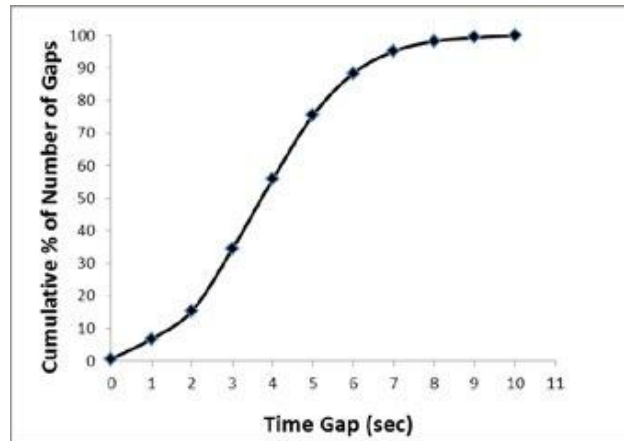


Fig.1 Cumulative curve for Gaps Accepted

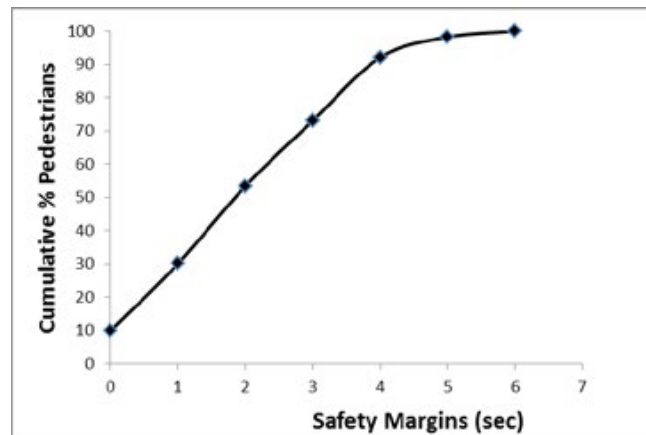


Fig.2 Cumulative Curve for Pedestrian Safety Margins

V.FINDINGS

The major findings of this study are given below:

- Two types of pedestrian crossings movements namely perpendicular movements and oblique movements are observed at the selected study location in Greater Noida. Apart from that approximately one out of seven pedestrian crosses the road in two stages.
- It is found that for majority of pedestrians, the crossing time varies between 4 sec to 10 sec and waiting time varies from 1 sec to 6 secs.
- It is further observed that waiting time is more in case of oblique and two step crossing; and for females and older people. Children are found to cross with very less waiting time. This may be attributed to their negligence to traffic rules.
- The average pedestrian crossing speed is estimated to be 1.36 m/sec for perpendicular movement conditions and as 1.98 m/sec for oblique movement conditions. As the pedestrian has to look both the sides during perpendicular movement which make their movement slow as compared to oblique movement.
- In the gap acceptance and safety margin analysis it is found that majority of pedestrians have the safety margins between 1 sec to 4 sec and gap accepted between 2 sec to 6 sec.

- Apart from that 10% pedestrians having safety margin 0 sec. They take very high risks while crossing.
- Among various categories of pedestrians females and older people have higher accepted time gaps and safety margins. Hence they are inclined to take very less risks than others.

VI.CONCLUSION

Among the crossing patterns more pedestrians crosses the roads in perpendicular direction and very few of them crosses the roads in two stages. The average crossing speeds at different study locations are varied with respect to various pedestrian characteristics like gender, age category, and baggage handling condition, volume and composition of traffic moving on road. Among them males and children have the higher crossing speeds. There is no significant variation in pedestrian's speeds due to handling of baggage. The majority of pedestrian are not inclined to take risks since the safety margins and time gaps were not very high but some pedestrians are there who take very high risks while crossing the roads. Approximately one out of five pedestrians has the safety margins of 0 sec. The pedestrian crossing behavior analysis is the important factor for deciding the assurance of pedestrian safety on roads and the pedestrians waiting time can be used to decide the need of pedestrian facility in the area.

This paper provides an analysis of various pedestrian crossing behaviors at signalized intersections under mixed traffic conditions and this paper is extended to develop pedestrian delay models and pedestrian level of service models at signalized intersections. Pedestrian-vehicular interaction and the influencing factors were analyzed in this paper and could provide some valuable insights for improving pedestrian safety at signalized intersections. This work can further be extended by taking a much larger sample thereby giving better statistical results. Analyzing the pedestrian crossing behavior including pedestrian arrival pattern with influencing parameters would increase the robustness of this work in future.

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