

# To Study Traffic Characteristics of Urban Midblock Section Influenced by Crossing Pedestrians under Mixed Traffic Conditions

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## Abstract

Pedestrian is one of the important component in the urban transportation system and also vulnerable at un-protected mid-block locations under mixed traffic conditions. Crossing by pedestrians on midblock sections of urban roads is very common in developing countries such as India. The locations where the pedestrians cross the road are invariably undesignated with no pedestrian cross marks. These crossings at undesignated locations have two-fold effects. First, pedestrians put themselves at risk, and, second, traffic speed and capacity are adversely affected. At unprotected mid-block locations, some of the vehicles may yield to pedestrians who are already at crosswalk location. However, some of the pedestrians are using forced gaps to cross the road. Hence, while pedestrians use the mid-block crosswalk with forced gaps, which decreases the vehicular flow characteristics. The pedestrian sidewalks do not show a direct effect on the vehicular flow characteristics when the pedestrian has pleasant walking facilities. The present study has analyzed the effect of the pedestrian crossing on the characteristics of vehicular flow at the mid-block location under mixed traffic conditions.

**Keyword- Pedestrian, Speed, Capacity, Midblock**

## I. INTRODUCTION

Traffic has grown in recent years with urbanization. In the recent scenario traffic is the major consent for any developing nation. The un-protected mid-block location is one of the important components in the urban transportation system for pedestrian activities under mixed traffic conditions especially in countries like India. The number of such un-protected mid-block pedestrian road crossing activities has been increasing in Indian context and growth of these activities may also result in pedestrian accidents. The increase in un-protected midblock pedestrian road crossings has been a significant effect on vehicular characteristics such as an increase in travel times and a decrease in vehicle speed. At signalized midblock and intersection, there is the complete right-of-way to pedestrians and vehicles as it results a decrease in pedestrian and vehicle conflicts as well as the severity of conflicts. In general, there are two types of crossings i.e. at-grade and grade separated. If the pedestrians are completely segregated (grade-separated) with vehicular traffic, then there is no effect of pedestrian crossings on vehicular flow characteristics. The grade-separated facilities are provided exclusively based on the vehicle as well as pedestrian traffic intensity. If such grade separated crosswalks are too apart from each other, then pedestrians either change their road crossing choice according to their destination which will result in more travel time or pedestrian will use forced gaps to cross the roads. Also, due to poor construction of grade separated facilities and roadside development, pedestrians usually cross the road at unprotected mid-block locations under mixed traffic conditions. However, in mixed traffic condition, it is very rare to get adequate vehicular gaps to cross the road. Hence, pedestrians will exhibit non-complaint road crossing behavior, causing more interference with vehicles. It leads to a rigorous change in vehicular flow characteristics such as speed and flow. The present study is carried out with the objective to study traffic flow characteristics at such sections.

## II. LITERATURE REVIEW

Hakkert et al. (2002) evaluated the effect of the pedestrian crosswalk warning system on vehicle speed by means of embedded flashlights in the pavement. Some authors addressed the characteristics of vehicles and pedestrians on different crossing conditions by studying the three conditions of the pedestrian crossing, including crossing freely, crossing at the non-signalized crosswalk, and crossing at the signalized crosswalk. From the results, they concluded that selecting an appropriate crossing mode for pedestrians can effectively decrease the vehicle delay, especially when the heavy pedestrian flow exists (Shumin and Yulong 2007). Bak and Kiec (2012) studied the influence of mid-block pedestrian crossings on roadway capacity by the simulation model. Duran and Cheu (2013) studied the effect of crosswalk location as well as the pedestrian volume on roundabout capacity by the simulation model. From the results, they concluded that if the crosswalk is placed further upstream from the yield line then the entry capacity

of roundabout approach increases. Chandra et al. (2014) studied the effect of pedestrian cross flow on the capacity of urban arterials in mixed traffic condition. Raymond and Knoblauch (2000) studied the effect of crosswalk markings on vehicle speed. From the results, it was found that drivers slightly reduce vehicle speed by yielding to the pedestrians. Black et al. (1988) collected land use data on main roads in the Sydney area to identify incompatibilities between land use and traffic to help formulate land use/transport policies. Bang et al. (1995) obtained Speed-flow relationships for interurban rural roads from a combination of direct speed-flow measurements and simulation, using the VTI microscopic simulation model for two-lane, two-way undivided roads. Bang (1995) revealed that in many Asian countries, the range and intensity of side friction are so great that these activities need to be incorporated explicitly into procedures for calculation of speed and capacity of road links. Ishaque and Noland (2005) discussed issues surrounding pedestrian micro-simulation modeling in urban traffic networks. The author used the vehicle following model of VISSIM to simulate pedestrian flow characteristics. Chiguma (2007) analyzed the effect of these factors on traffic performance measures on urban roads. He adopted an empirical case study methodology Dar-es-salaam city in Tanzania to determine the effect of side friction factors on the traffic performance measure. Munawar (2011) analyzed the effects of the characteristics of urban roads, especially the side friction, in reducing capacity and speed. It is then compared the results to the capacity and speed predicted by Indonesian HCM. Dhamaniya and Chandra (2014) demonstrated the effect of pedestrian crossings on the midblock capacity of an urban arterial road. The results show practically no influence on capacity when the pedestrian cross flow is less than 200 pedestrians per hour. The capacity, however, is reduced by 30% when the pedestrian cross flow is increased to 1,360 pedestrians per hour. Kadali and Tadi (2015) analyzed the effect of the pedestrian crossing on the characteristics of vehicular flow at midblock location under mixed traffic conditions. The results indicate that the pedestrian forced gap condition has a significant effect on vehicular characteristics. The vehicular speeds were implicitly affected with pedestrian crossing when compared to without pedestrian crossing location under mixed traffic conditions.

### III. SITE SELECTION

Following are the factors considered for selection of study section.

- The friction section should free from the effect of any kind of side frictions other than pedestrian crossing.
- The friction section should free from the effect of intersection gradient, horizontal and vertical curve with uniform geometry.
- The friction section should have good traffic and pedestrian flow.

By considering all the above criteria the section was selected Vile Parle, Mumbai. The section was a location on a four-lane urban midblock section. The Google Earth Image and the photograph of the section have been shown in Fig. 1.

### IV. DATA COLLECTION AND EXTRACTION

To establish the effect of the pedestrian crossing on the speed and capacity of the urban road the data collected at highly populated city Mumbai which is called economic capital of India. To assess the effect of pedestrian crossing it is essential to conduct the survey at the section with and without the effect of the pedestrian crossing on the urban road. The mid-block section with the effect of the pedestrian crossing is termed as 'friction section' whereas the mid-block location where there is no any such influence observed is termed as 'base section'. Video graphic survey was conducted at Mumbai and Spot speed survey at Surat at the base section. The base section is so selected that it was free from the effect of any side friction as well as free from effect of horizontal or vertical curve. Data were collected on a typical weekday covering peak as well as off-peak hours in morning and evening times with normal environmental condition. Friction section was selected on a four-lane divided urban mid-block section with a median opening, which is partially uncontrolled by unmarked crosswalks located in Vile Parle, Mumbai. Base section was selected at Gaurav Path, Surat SVNIT College which is 6-lane divided Urban-arterial road. The video-graphic data was captured with the help of high-resolution cameras to capture vehicular characteristics. The data were recorded for a period of 6 hours from 7 AM to 2 PM because of the high demand for pedestrian crossings.



Fig. 1: Image and Location of Vile Parle section from Google Earth

## V. DATA EXTRACTION

### A. Volume Count

Vehicular volume count has been carried out using Avidemux 2.6. The software converts one-second video into 25 frames means at every 40 microseconds. A line on screen was marked using screen marker software and vehicles passed in one minute was counted. The vehicles classified into five different categories as shown in Table-1. No of each category of vehicles crossing the section per one minute was counted and noted in excel sheet as shown in the screenshot.

Vehicle Type	Vehicles included	Length (m)	Width (m)	Rectangular Plan Area (m <sup>2</sup> )
Small Car	Car	3.72	1.44	5.36
Big Car	Big utility vehicle	4.58	1.77	8.11
Heavy Vehicle	Standard bus	10.10	2.43	24.54
3-wheeler	Auto-rickshaw	3.20	1.43	4.48
2-wheeler	Scooters, Motorcycles	1.87	0.64	1.20

Table 1: Types of Vehicles and Size

### B. Speed Measurement

Vehicle speed data were extracted by using Avidemux 2.6 software by each forward click which is shown in Fig. 2. In this software open the videography and mark the two line at the vehicle entry point and the second one is the vehicle out point. They two line distance is known distance .this line is marked by using screen marking software. After the screen marking, we take the reading to note the entry time of the vehicle and exit time of the vehicle in the excel sheet.

## VI. ANALYSIS OF DATA

### A. Traffic Volume and Composition

From the classified volume count the variation in flow with time has been observed as shown in the following figure. Volume composition is also plotted for all sites.

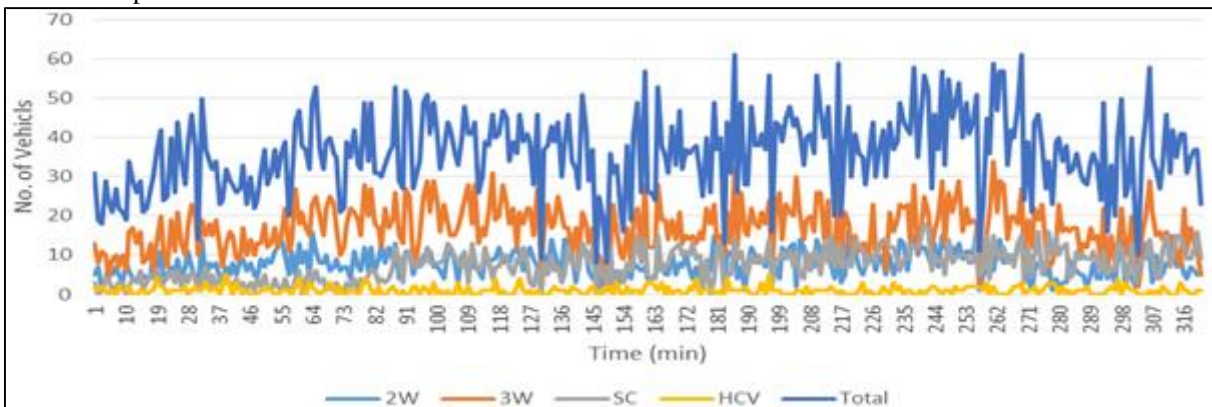


Fig. 2: Vehicular flow at Vile Parle

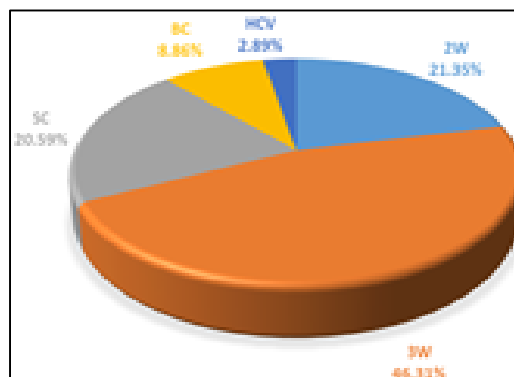


Fig. 3: Traffic Composition at Vile Parle

From the classified pedestrian count, the variation in the flow of pedestrian with time has been observed as shown in the following figure. The maximum pedestrian cross flow was as high a 1500 ped/hr and the minimum was 84 ped/hr and the average pedestrian cross flow was 673 ped/hr.

#### B. Speed Characteristics

Speed characteristics of based and friction section has been studied using frequency distribution and cumulating frequency distribution curves. Fig. 3 shows these curves for different classes of vehicles.

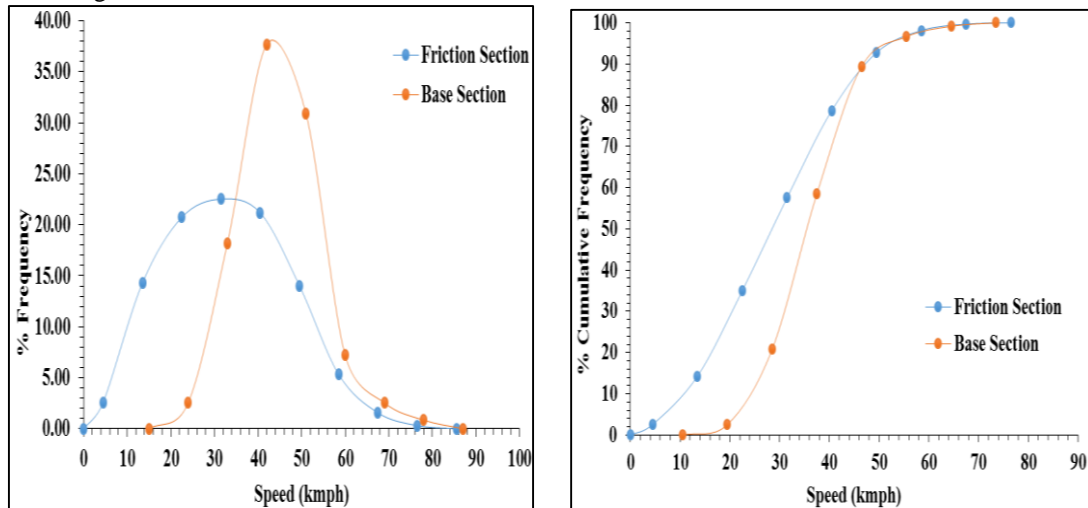


Fig. 4: Speed characteristics for base and friction section for 2W

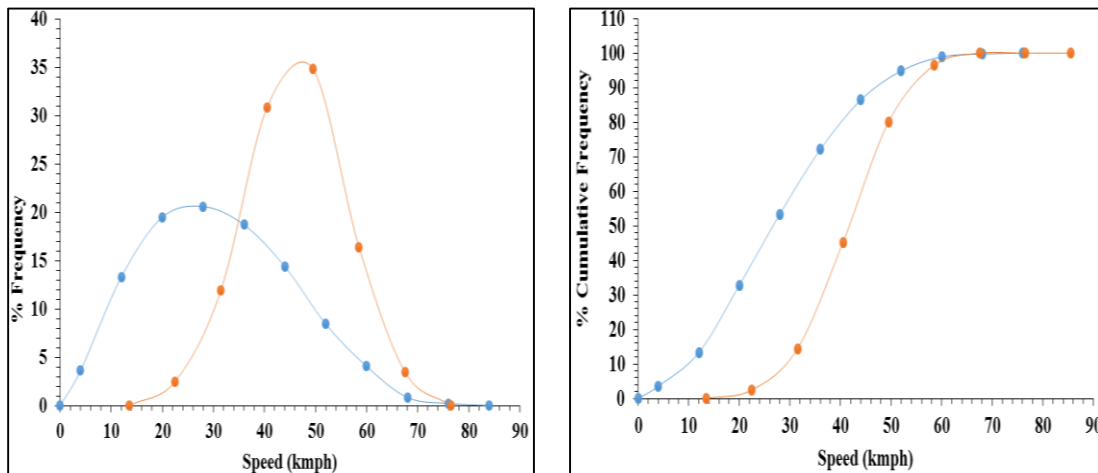


Fig. 5: Speed characteristics for base and friction section for 3W

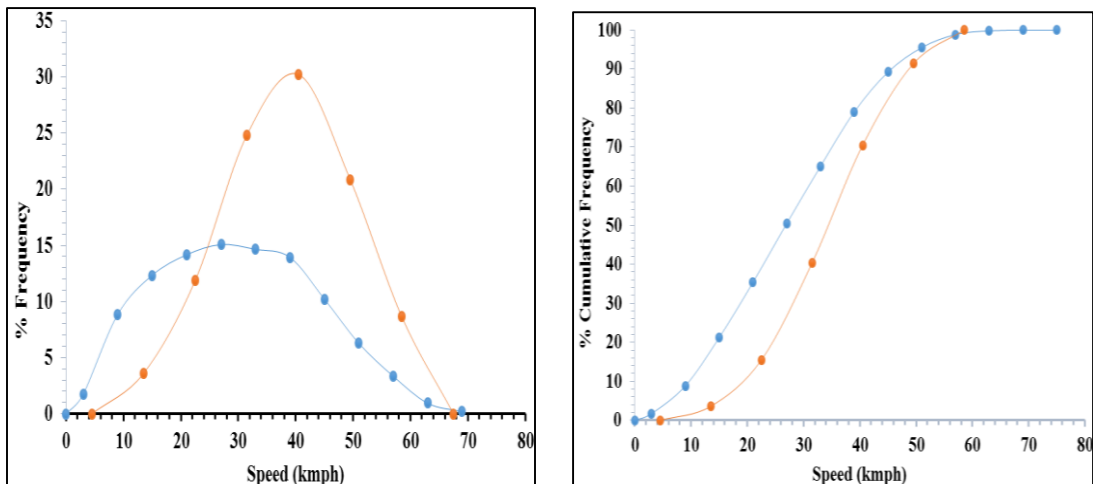


Fig. 6: Speed characteristics for base and friction section for 3W

Speed Characteristics	2W		3W		SC		BC		HV	
	B	F	B	F	B	F	B	F	B	F
Maximum Speed (kmph)	71.05	75.00	62.79	69.23	69.23	75.00	71.00	66.67	71.00	62.07
Minimum Speed (kmph)	20.15	2.38	14.00	2.20	19.00	3.31	23.00	6.10	20.00	6.90
Mean Speed (kmph)	40.99	33.54	38.77	30.36	46.29	31.62	47.42	29.20	47.06	28.31
Total No. of Vehicle Observed	236	1274	278	3072	201	1802	138	505	104	226
15th Percentile Speed (kmph)	32.00	18.36	27.00	15.30	37.00	16.82	36.00	15.87	37.00	16.82
50th Percentile Speed (kmph)	40.91	33.33	39.00	30.00	46.55	30.51	47.37	28.12	48.00	27.69
85th Percentile Speed (kmph)	50.00	48.65	51.05	45.00	57.45	47.37	56.85	43.90	58.55	40.00
98th Percentile Speed (kmph)	61.57	62.07	60.15	58.06	67.00	60.00	66.53	57.92	65.00	50.71
B - Base Section, F - Friction Section										

Table 2: Speed Characteristics at Base and Friction Section

From Figure 4, it can be seen that modal speed for the base section is higher than that of the friction section. Table 2 shows the comparison of the speed characteristics of different classes of vehicles. It can be seen that speed at the friction section is less than base section. However, there is not much difference in 85<sup>th</sup> percentile speed but the difference in 50<sup>th</sup> and 15<sup>th</sup> percentile speed is much significant.

### C. Capacity Estimation

The capacity of the friction section is estimated. The extracted speed and volume data were for one minute count period were converted to five minute count period. The speed obtained was used for pcu estimation using the equation suggested by Chandra and Kumar (2003) based on velocity and area ratio. The stream speed is worked out for the section by taking the weighted average of speed of all categories of vehicles. The fundamental relationship suggested by Greenshields (1935) was used to determine the density of the stream as it is very difficult to determine density in the field.

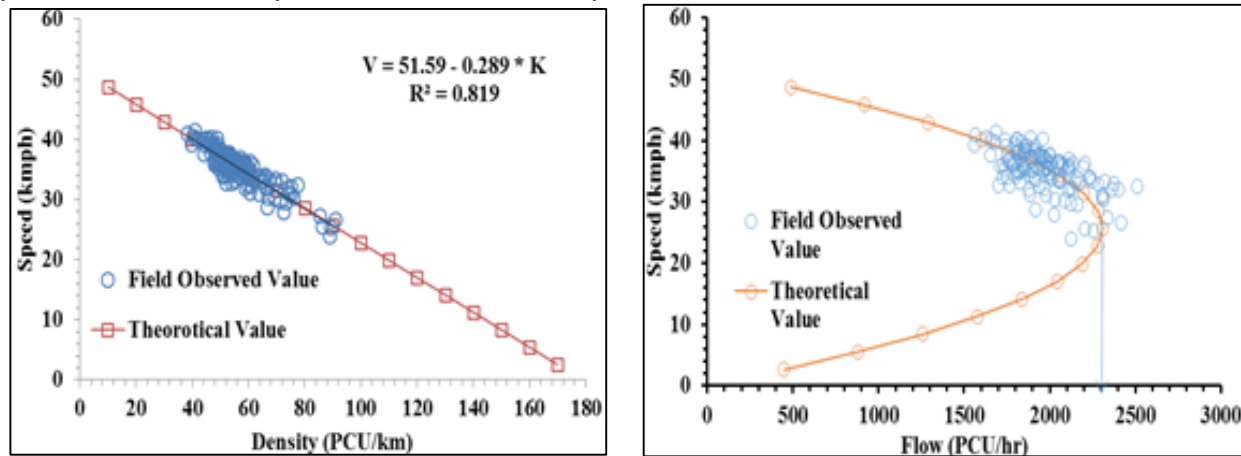


Fig. 7: Speed-Density and Speed-Flow Plot

## VII. RESULT AND DISCUSSION

Speed characteristics of base and friction section show that there is a significant difference in speed in all categories of vehicles. It was found there is no much different in 85<sup>th</sup> percentile value for all classes of vehicles. However, speed difference in 50<sup>th</sup> and 15<sup>th</sup> percentile speed is significant. The capacity of the four-lane urban base section is 2700 pcu/hr as per Indo-HCM 2017 whereas in the present study the capacity of the section is obtained as 2312 pcu/hr. The pedestrian crossings negatively affect the capacity of the section and it reduced by 14.37%.

## VIII. CONCLUSION

The present study carried out to study traffic characteristics like speed and capacity of such friction section and compared the same with the base section. It was found that the speed of all classes of vehicles is influenced by crossing pedestrians. However, at a lower flow, there is no much difference but is significant at higher vehicular flow. The capacity of an urban road is affected by many parameters including many types of side frictions. The pedestrian crossing is also such important side friction which is not considered in HCM 2010 and Indo-HCM 2017. The speed of all classes of the vehicle is influenced by crossing pedestrians. Moreover, the capacity of the friction section reduced significantly than that of the base section. At the study location capacity of the section is found 14.37% less than that of the base section capacity.

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