Study on Acceleration and Deceleration Characteristics of Vehicles Influenced by Crossing Pedestrians at Urban Midblock Sections

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Abstract: Pedestrian crossing is commonly observed phenomenon on urban midblock section which interferes and cause delay to the vehicles running vehicles. For estimation of delay incurred to vehicles due to such interferences acceleration and deceleration characteristics are inevitable. The present study has been carried out to study acceleration and deceleration characteristics of different categories of vehicles commonly observed in the urban area. The Performance Box, which is a Global Positioning System (GPS) based instrument was used and mounted on the vehicles to take significant number of samples for different categories of vehicles. The acceleration and deceleration models have been generated for different classes of vehicles to estimate acceleration and deceleration rate at given operating speed. The result showed that the speed-acceleration and the speed-deceleration profiles follow exponential relationship. Results of the study may useful for development of a simulation program, estimate delay to vehicles under mixed traffic conditions on urban arterials.

Keywords: Acceleration, deceleration, pedestrian, urban roads

1 INTRODUCTION

Pedestrian crossings on urban midblock sections are most commonly observed phenomenon in developing countries due to lack of facilities and to save time occurring due to long travel to access nearest pedestrian crossing facility. Such crossing pedestrians not only inversely affect the traffic characteristics but also put themselves at high risk of collision with approaching vehicles. As per the *Global Mobility Report (GMR)* 2017, 49 % of all traffic deaths occurs among the pedestrian and cyclist. The study in Mumbai revealed that pedestrians accounted for over 50% of the 490 fatalities that occurred in road crashes in the year 2017 (Singh 2018). The pedestrian crossing the roads affect the incoming traffic as shown in Figure 1. Thus the influenced vehicle has to decelerate to avoid the probable conflict/collision with crossing pedestrian for safety purpose. Thus vehicle decelerates to some minimum constant speed and continues with that speed for some distance till the conflict with a pedestrian is avoided and then again accelerates to regain its desired speed. The acceleration and deceleration properties are mostly used for design of amber time for crosswalks at midblock or at a signalized intersection. For estimation of delay incurred to vehicles due to pedestrian interferences at such locations acceleration and deceleration characteristics are inevitable. Furthermore, it is also useful in emission modeling of vehicles and also microsimulation studies for enhancing accuracy.

Figure 1. Pedestrian crossing scenario at an urban midblock crosswalk

2 LITERATURE REVIEW

There had been a number of attempts to study the acceleration and deceleration models for homogeneous conditions, some of them are discussed in the following section. Besley (2001) developed the acceleration and deceleration models for the car at a stopping signal. Mousa (2002) analyzed the delay at a signalized intersection and found that the intersection influencing zone on speed is about 330m. Wang *et al.* (2004) evaluated the acceleration of cars with help of GPS data between the acceleration behaviors of straight and turning maneuvers and also evaluate the effect of the speed limits on acceleration rates. They have developed polynomial models for acceleration behaviors. Rakha *et al.* (2004) proposed the vehicle dynamic model for acceleration characteristics of light-duty vehicles. Wang *et al.* (2005) have studied the deceleration behavior on the urban road at stop sign controlled intersection using GPS data and found that there was no clear relationship between the average and maximum deceleration rates and approach speeds. Regression method was used for modeling speed and deceleration time. Arasan and Koshy (2005) describe a methodology for simulating traffic flow in heterogeneous traffic conditions. Minh *et al.* (2007) proposed the acceleration and deceleration models for a motorcycle at a signalized intersection in mixed traffic condition. El-Shawarby *et al.* (2007) evaluated the drivers' deceleration behavior at the signalized intersection using a global positioning system and found the mean observed deceleration as 3.27 m/s^2. Ngoduy (2008) proposed a second order macroscopic model for traffic flow operations on ramps and found that the acceleration lane length affects the traffic characteristics. Mehar *et al.* (2013) proposed the exponential distribution for the speed-acceleration relation of vehicles plying on the multilane highway. Weng *et al.* (2015) reported the affected zone of manual toll collection and electronic toll collection on approaching vehicle is within 240m. Yang *et al.* (2016) investigate the acceleration characteristics for ramps for different grades and developed speed profiles for the design of ramp. A piecewise-constant acceleration model was developed and distance versus speed profiles for the acceleration-length design was also introduced. In the study of Bokare and Maurya (2017) the acceleration and deceleration of trucks, motorized three-wheeler and two-wheeler and car for signalized intersection were evaluated and relationships were developed using regression analysis. Tan *et al.* (2017) proposed a microscopic spatial-temporal method to capture trajectory at a signalized intersection and thus optimization was carried out for signal timings to reduce the overall delay. Yang *et al.* (2018) proposed the variable acceleration profile for the acceleration lane design over the constant acceleration using the piecewise method of evaluation. Scanlon *et al.* (2018) evaluated the acceleration behavior of the drivers before the real world crashes at the intersection and the results showed that the drivers' accelerate aggressively in the pre-crash scenario.

Thus many studies are carried out to assess the acceleration and deceleration characteristics of vehicles approaching towards the signalized intersection, toll plazas, uncontrolled intersections. But very limited studies are available on the acceleration and deceleration characteristics of different categories of the vehicle in mixed traffic condition either at midblock or intersection. Hence in the present study, the attempt is made to study the vehicular characteristics such as speed, acceleration, and deceleration of all categories of vehicles which get affected by crossing pedestrian at midblock using the Global Positioning based instrument.

3 OBJECTIVES OF STUDY

Pedestrian crossing at urban midblock section is a common phenomenon observed on urban roads in developing countries like India. Vehicles negotiating from the sections affected by crossing pedestrians are interfered by such pedestrian activity. The speed of vehicles and ultimately stream speed reduces. Hence, the overall efficiency of such link reduces. For delay estimation incurred to vehicles on account of pedestrian activity the acceleration and deceleration characteristics are required which is not mostly explored yet. Hence, the present study has been attempted with the prime objective to study acceleration and deceleration characteristics of different categories of vehicles mostly observed on urban roads.

4 METHODOLOGY

The pedestrians cross the roadway at midblock sections for time-saving and to stay away from long walking distance which is common in urban areas, mostly in developing countries. This unlawful pedestrian crossing affects the vehicle whose path gets interfered or about to interfere by pedestrians. Thus vehicles have to give way to the crossing pedestrian for safety purpose. Thus, the approaching vehicle when found a pedestrian crossing the midblock it decelerates so as to avoid the collision, then it moves with the constant speed till the pedestrian crosses the approaching vehicle and again it starts accelerating to regain its desired speed. In some case vehicles need to come to the complete stop position. To analyze the variation in speed, acceleration and deceleration characteristics the Performance Box, which is a Global Positioning System (GPS) based instrument was used for the data collection. About thirty runs which are interfered by crossing pedestrian for each class were taken to capture all the variations in drivers' and traffic characteristics. The sample speed –distance plot obtained from the performance box is as shown in Figure 2. Figure 2(a) and Figure 2(b) shows the speed-distance plot for 2W and HV respectively. The speed profile is divided into three different zones with five points namely A, B, C, D, and E. The point A denotes the starting point of deceleration with the approaching speed U_0, the point B denotes the end of the deceleration cycle. Similarly, point D denotes the start of the acceleration cycle and the point E denotes the end of acceleration cycle with the U_1 as the desired speed. The point C denotes the crosswalk of the pedestrian. Then the analysis is carried out for the region AB and the region DE for deceleration and acceleration zone respectively. The acceleration-speed and deceleration - speed relationship is developed by plotting scatter plot and regression analysis.

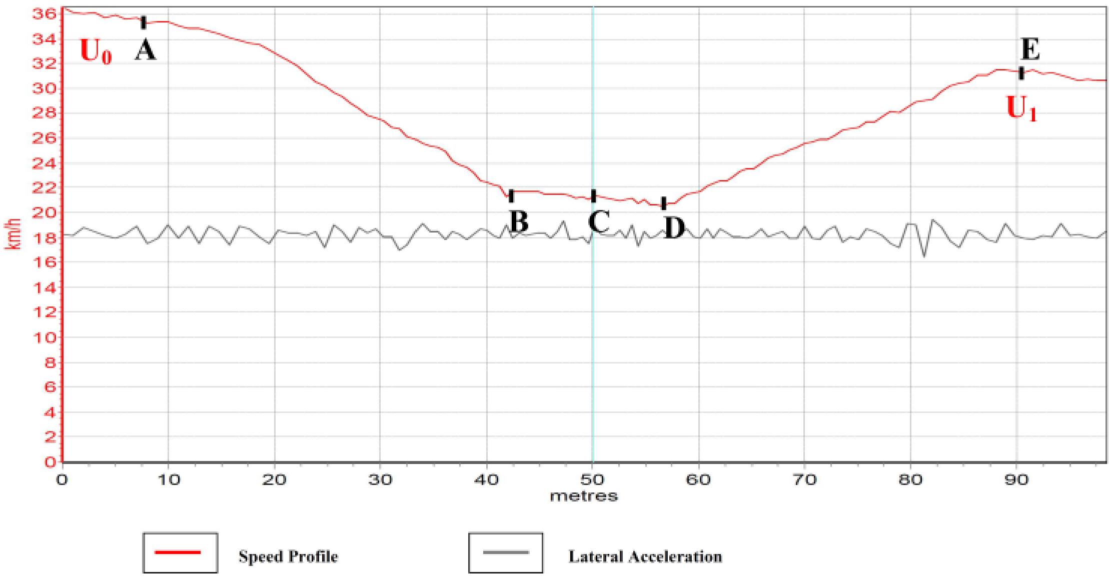


Figure 2 (a) Speed- distance plot for 2W

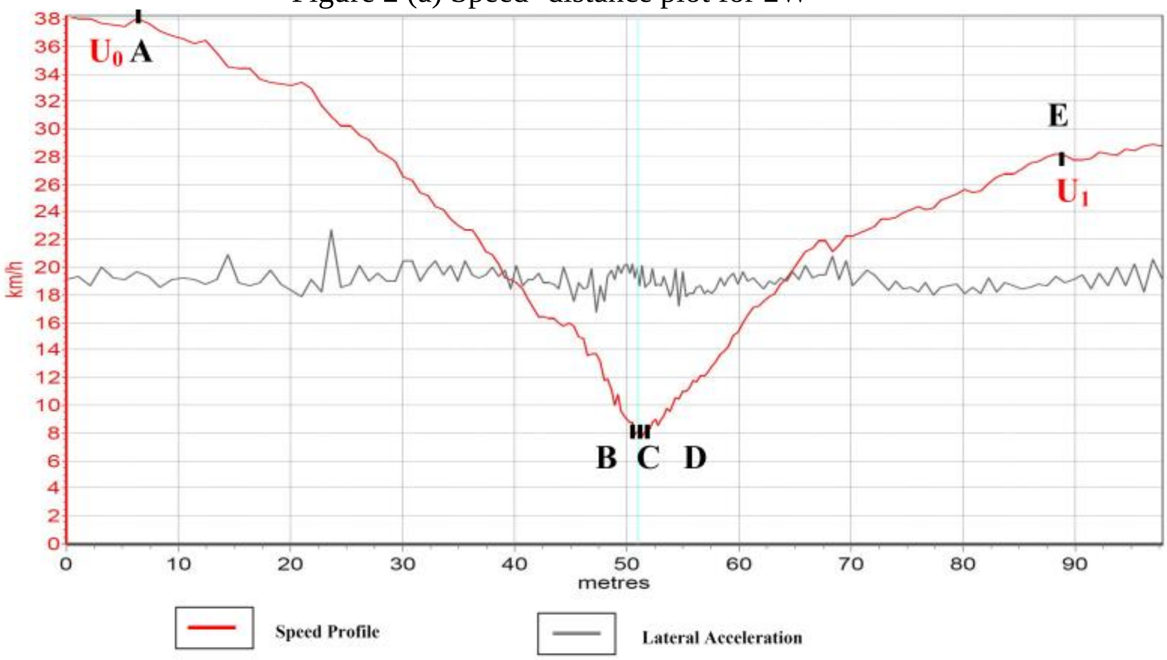


Figure 2(b) Speed- distance plot for HV

Figure 2. Speed –distance plot from Performance Box

5 DATA COLLECTION

The data was collected at the pedestrian crosswalk at Jay Mangal BRTS stand which is located in Ahmadabad, Gujarat as shown in Figure 3. The section is located on the 4-lane divided urban arterial. The probe data was collected using a Performance Box device mounted over different categories of vehicles. The vehicle mounted with a Performance Box was traveled on the selected urban arteries having a pedestrian crossing section. The run of vehicles started about 750 m before pedestrian crossing location and continued around 750 m after the pedestrian crossing location. A number of such runs have been made with different categories of vehicles. Depending on pedestrian cross flow, during each run of vehicle interaction was not possible with a pedestrian(s). Only such runs were considered for analysis purpose having the interaction with a pedestrian(s) and other runs were discarded. During the data collection, it was found that pedestrians mostly avoid crossing the road when a heavy vehicle passes the section. So, the speed of the heavy vehicle is not much affected due to the pedestrian crossing. Only a few samples of the heavy vehicle were obtained with interacting pedestrians and are considered for analysis.

For the analysis purpose, the approaching vehicles were categorized into five different classes as shown in Table 1 and Figure 4 according to physical dimensions observed in the field. The performance box data for two-wheeler (2W), three wheeler (3W), heavy vehicle (HV) were taken from the real approaching traffic. The data from a small car (SC) and big car (BC) was collected using the hired vehicle as most of the drivers' of SC and BC are private owners and they don't allow the volunteers to attach instrument in their vehicles.

Figure 3. Location map of crosswalk under study with probe vehicle

Table 1. Vehicle Category used for present study

	Vehicles Included	**Length (m)**	**Width (m)**	**Rectangular Plan Area (m^2)**	**Number of samples**
2-wheeler (2W)	Scooters, Motorcycles	1.87	0.64	1.20	35
3-wheeler (3W)	Auto-rickshaw	2.20	1.40	3.08	30
Small Car (SC)	Car	3.72	1.44	5.36	34
Big Car (BC)	Big utility vehicle, XUV, SUV	4.58	1.77	8.11	33
Heavy Vehicle (HV)	Standard Bus, Trucks	10.10	2.43	24.54	25

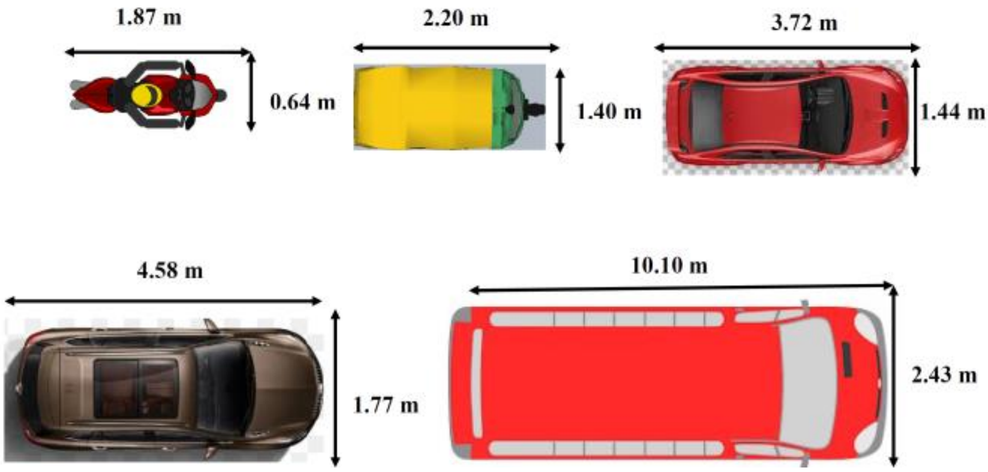


Figure 4. Plan view of vehicle class considered

6 ANALYSIS OF DATA

The videographic data was used to evaluate the traffic and pedestrian characteristics at the urban midblock section. The traffic composition obtained after extraction of data is as shown in Figure 5. The results showed that the proportion of BC was high (about 27.34 % of total vehicular traffic) and HV were found to be low about 1.38 % of total traffic. The mean traffic flow on study section was found to be about 1774 vehicles/hour (veh/hr) and mean pedestrian cross flow was observed to be 48 pedestrian/hour (ped/hr). At the study location the maximum and minimum observed vehicular flow was 2268 veh/hr and 1404 veh/hr respectively whereas maximum and minimum observed pedestrian cross flow was 576 ped/hr and 270 ped/hr respectively.

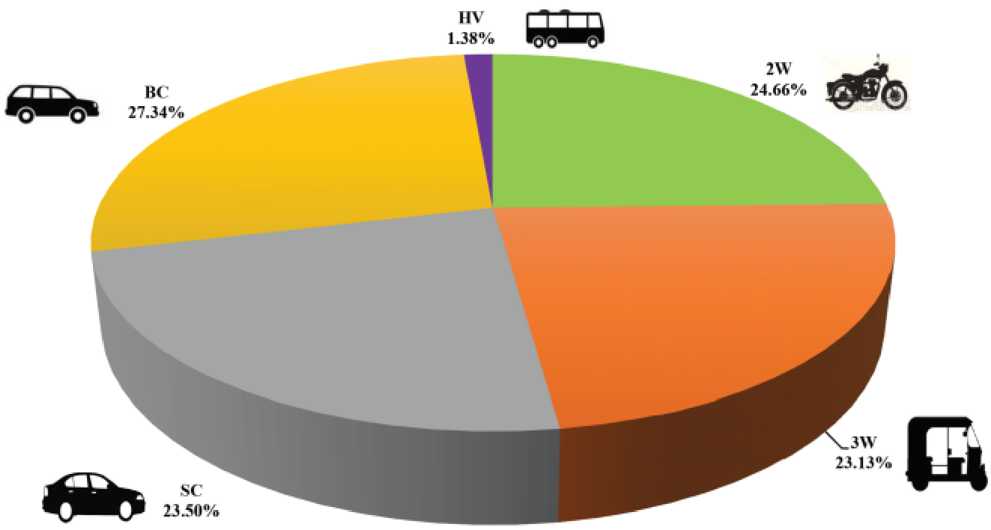


Figure 5. Traffic composition observed at study section

The collected data were then analyzed using Performance Box Software. The instantaneous speed, acceleration, distance, longitude, latitude etc. values were obtained from Performance Box Software for each 0.1 sec. Figure 6 shows the vehicle class wise variation in speed profile which is having interaction with the crossing pedestrian. It is observed that mostly the 2W, 3W, SC and BC are gets affected by the crossing pedestrian. While in case of approaching HV it was observed that pedestrians mostly avoid crossing the midblock section. So, the HV is the only class which gets minimal distress of the crossing pedestrian. The results show that the approaching speed for 3W was the minimum of all while for 2W and BC it was the maximum.

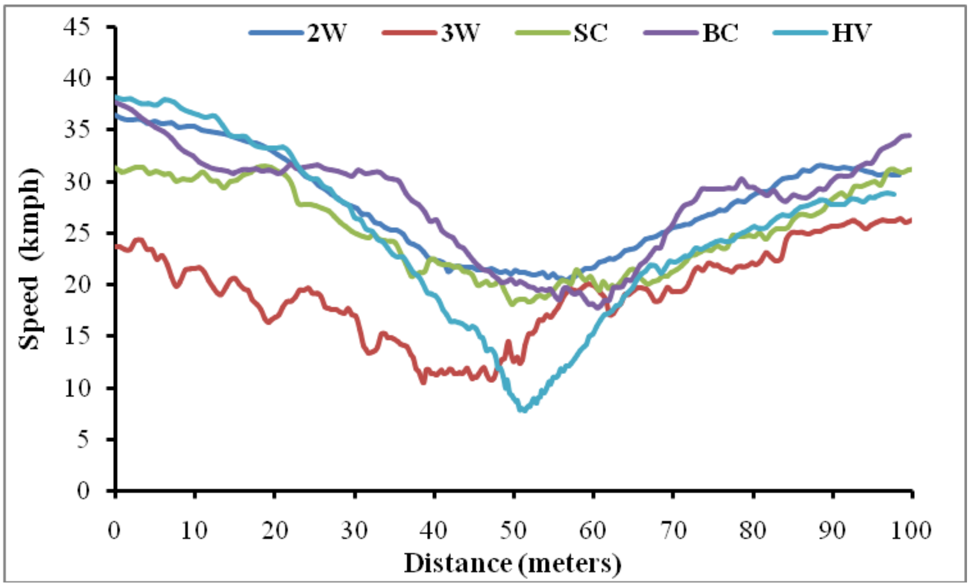


Figure 6. Speed-distance plot for all class of vehicles

6.1 Speed- Time Analysis

The sample speed- time graph for deceleration and acceleration zone is as shown in Figure 7 (a) and Figure 7 (b). Figure 7 (a) depicts the variation in speed with respect to time for various samples of 2W in deceleration cycle which shows the decreasing trend. Similarly, Figure 7 (b) depicts the variation in speed with respect to time for various samples of 2W in acceleration cycle which shows the increasing trend. Figure 7(c) and 7(d) shows the speed-time variation for small car.

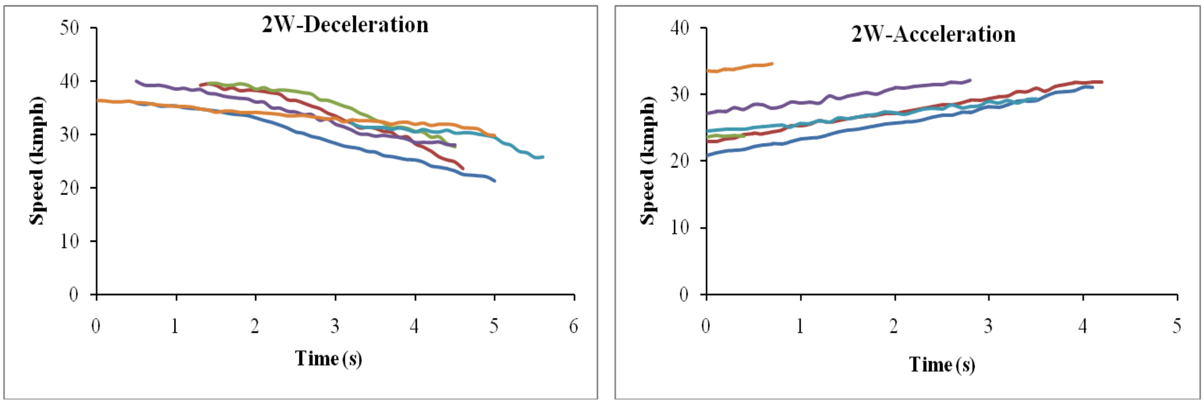


Figure 7 (a) Speed-time plot for 2W in deceleration zone Figure 7 (b) Speed-time plot for 2W in acceleration zone

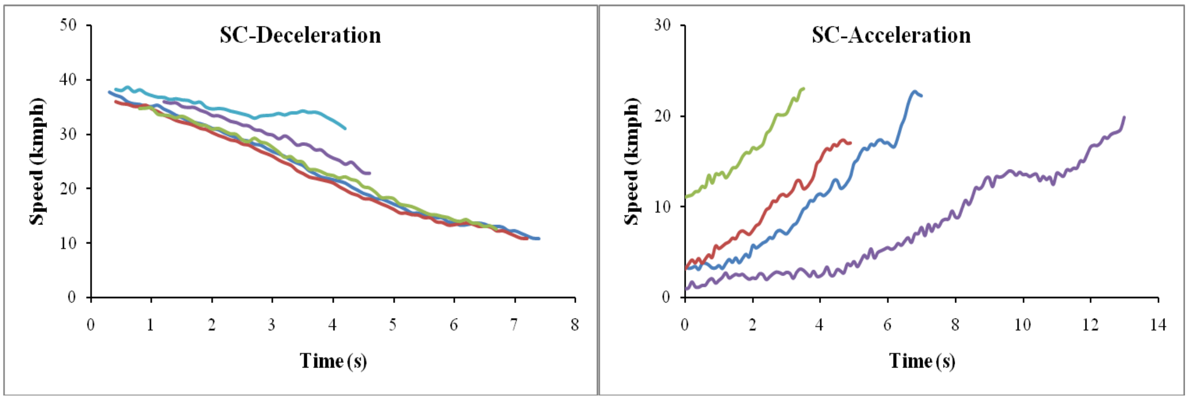


Figure 7 (c) Speed-time plot for SC in deceleration zone Figure 7 (d) Speed-time plot for SC in acceleration zone

Figure 7. Speed-time plot

Thus, from Figure 7(a) and 7(b) it is concluded that even in the same category the response of driver for deceleration is different for crossing pedestrian that is the time required for each vehicle to gain constant speed varies. Furthermore, on comparison of Figure 7(a) and 7(c) and Figure 7(b) and 7(d), it is clear that the time required for different classes of vehicles for deceleration and acceleration is different. The slope of speed - time graph gives acceleration (here for deceleration zone deceleration). On the other hand, the time for speed-acceleration plot was also varying for the vehicles in the same category illustrating the acceleration varies with respect to time. Hence, it is necessary to evaluate the speed- acceleration and speed-deceleration relationship for proper analysis of the driver's behavior for unlawful crossings, delay studies and for simulation studies.

6.2 Speed- Distance Analysis

The speed-distance plot for the different samples of 2W and SC is as shown in Figure 8 for the deceleration and the acceleration. The results showed that the approaching speed and desired speed for the same class of vehicle is different and thus variation is seen within the class and among the class. It was observed that the downstream speed U_1 is about 88% upstream speed U_0.

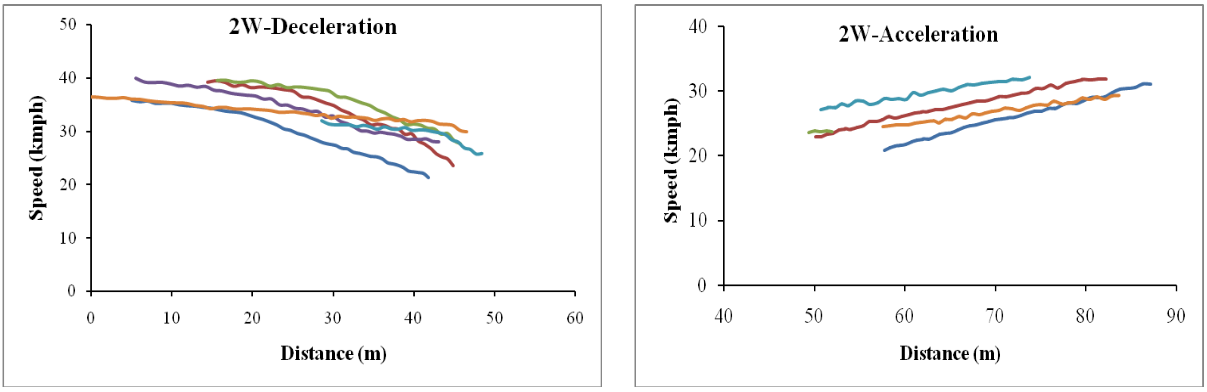
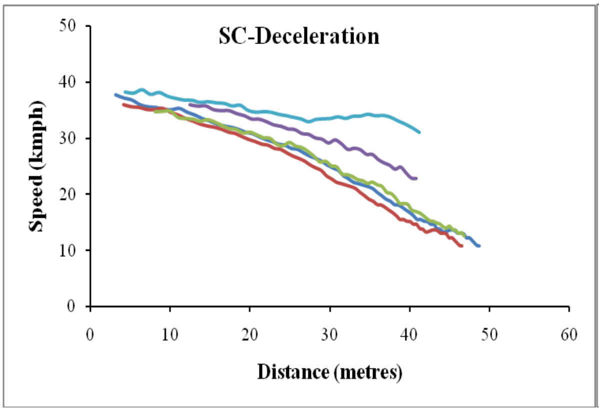


Figure 8(a) Speed- distance plot for 2W in deceleration zone Figure 8(b) Speed- distance plot for 2W in acceleration zone



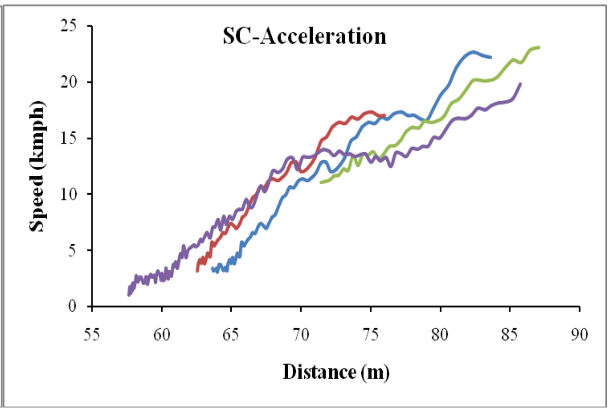


Figure 8(a) Speed- distance plot for SC in deceleration zone Figure 8(b) Speed- distance plot for SC in acceleration zone

Figure 8. Speed-distance plot for 2W

Table 2 shows the descriptive statistics for the influence zone of various classes of vehicles. It was observed that the constant speed zone is maximum for the 3W about 10.31m averagely, and minimum for the HV about 0.32 m averagely. The end of deceleration and start of constant speed zone is about 8.05 m from point C (walkway of a pedestrian) which was the maximum of all class. The start point of deceleration (point A) was at a maximum mean distance from walkway for HV about 43.90 m and minimum for 3W about 35.76 m. Also, the end point of acceleration is at a maximum mean distance from point C for 2W about 41.47 m and a minimum for 32.86 m for SC. This variation occurs due to SC having maximum accelerating capability than 3W. Thus from the descriptive analysis average of 100 m zone was selected as an influence zone for total acceleration, deceleration and constant speed cycles affected due to the presence of crossing of the pedestrian. The average distance for deceleration was about 87% of the acceleration distance for 2W, 3W and SC while for BC and HV the deceleration distance was found to be 16% to 20% more than the acceleration distance. These variations occurred because of the vehicular and acceleration characteristics related to this vehicle class.

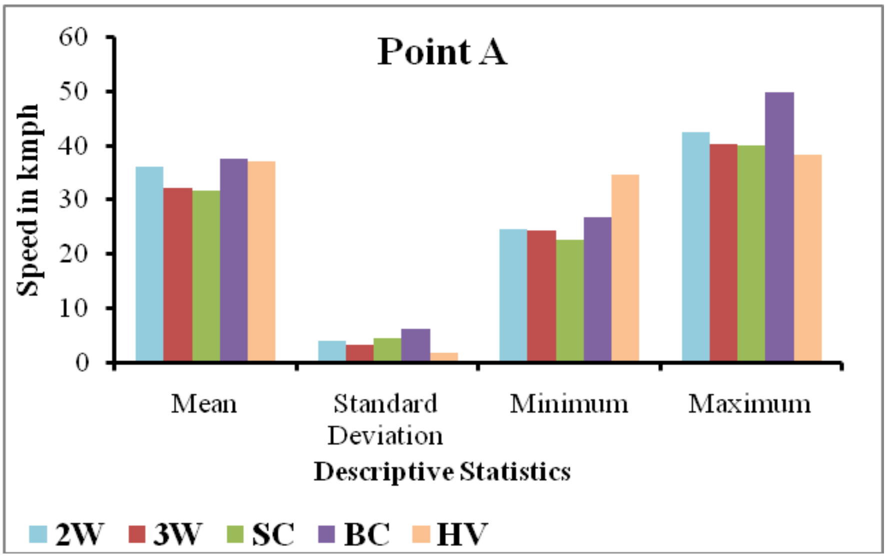


Figure 9(a) Descriptive statistics at point A

Table 2.Descriptive statistics for influencing zone

Vehicle Category	Parameter	A (m)	B (m)	D (m)	E (m)	Distance for Deceleration (A to B) (m)	Distance for Acceleration (D to E) (m)	Distance for Constant Speed (B to D) (m)	Total Distance (A to E) (m)
2W	Mean	-36.98	-3.82	3.70	41.47	33.16	37.78	7.52	78.45
	Standard Deviation	11.99	3.06	2.64	9.93	11.76	9.27	5.67	14.56
	Skewness	-0.52	-2.05	1.53	0.14	0.71	0.03	1.79	-0.36
	Minimum	-67.39	-14.41	0.51	23.11	16.63	20.15	1.01	50.81
	Maximum	-18.43	-0.50	11.33	62.58	64.43	58.48	25.74	98.81
3W	Mean	-35.76	-6.88	4.14	38.15	30.35	32.76	10.31	73.91
	Standard Deviation	9.68	7.98	3.08	11.37	13.08	11.01	7.66	13.46
	Skewness	0.33	-2.76	0.72	0.46	-0.88	0.44	1.59	0.02
	Minimum	-50.31	-35.37	0.00	16.27	-3.86	11.66	0.00	51.28
	Maximum	-17.71	0.00	11.52	65.18	50.31	58.12	35.37	98.45
SC	Mean	-39.48	-1.72	1.65	32.86	35.44	38.49	8.60	82.53
	Standard Deviation	10.14	1.89	1.81	12.96	25.12	16.40	10.72	19.53
	Skewness	-0.07	-1.15	1.41	0.05	-1.26	0.90	1.38	-0.93
	Minimum	-53.18	-6.56	0.00	15.81	-35.74	11.06	0.00	38.02
	Maximum	-26.70	0.00	6.63	53.04	75.18	73.76	34.25	103.38
BC	Mean	-43.49	-8.05	0.55	39.04	37.76	31.21	3.38	72.34
	Standard Deviation	15.03	14.85	16.94	15.46	9.94	12.73	3.69	17.79
	Skewness	-0.61	-3.21	-3.35	0.24	0.07	0.27	1.27	0.20
	Minimum	-75.18	-60.01	-60.01	12.45	25.45	15.81	0.00	46.92
	Maximum	-21.84	0.00	17.12	70.11	51.08	53.04	13.19	100.45
HV	Mean	-43.90	-0.16	0.16	37.81	43.73	37.66	0.32	81.71
	Standard Deviation	4.19	0.24	0.24	3.69	4.14	3.74	0.49	7.74
	Skewness	1.01	-1.73	1.73	0.80	-0.76	1.08	1.73	-0.19
	Minimum	-47.49	-0.44	0.01	34.51	39.28	34.50	0.03	73.81
	Maximum	-39.30	-0.02	0.44	41.79	47.47	41.78	0.88	89.29

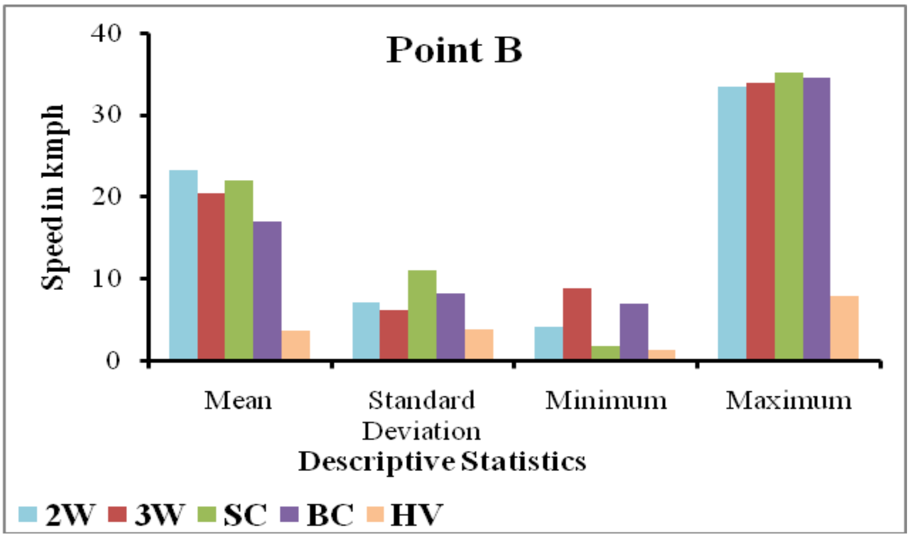


Figure 9(b) Descriptive statistics at point B

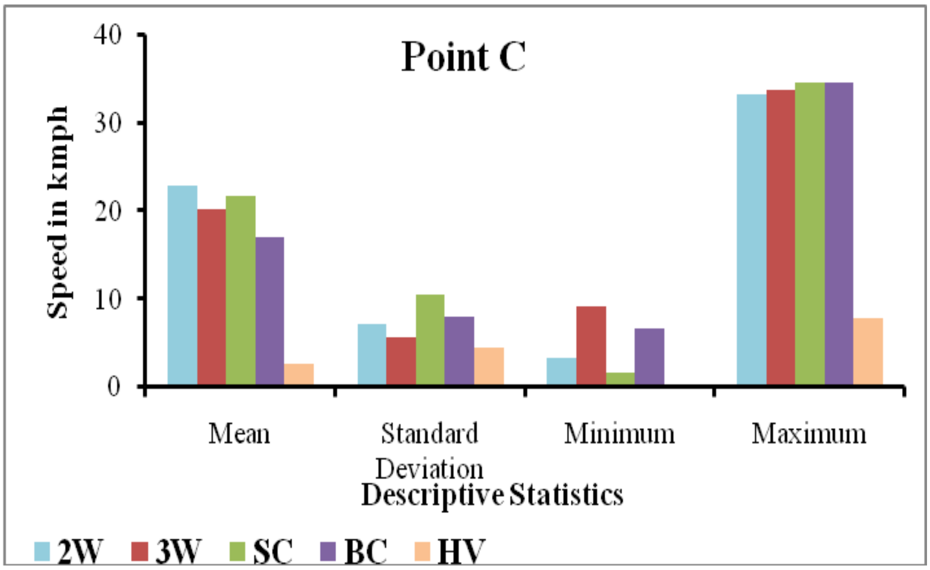


Figure 9(c) Descriptive statistics at point C

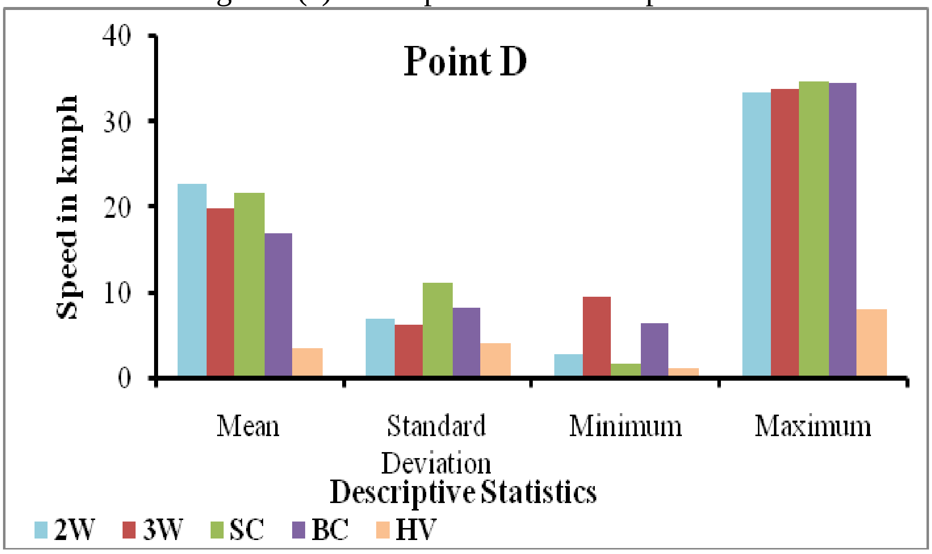


Figure 9(d) Descriptive statistics at point D

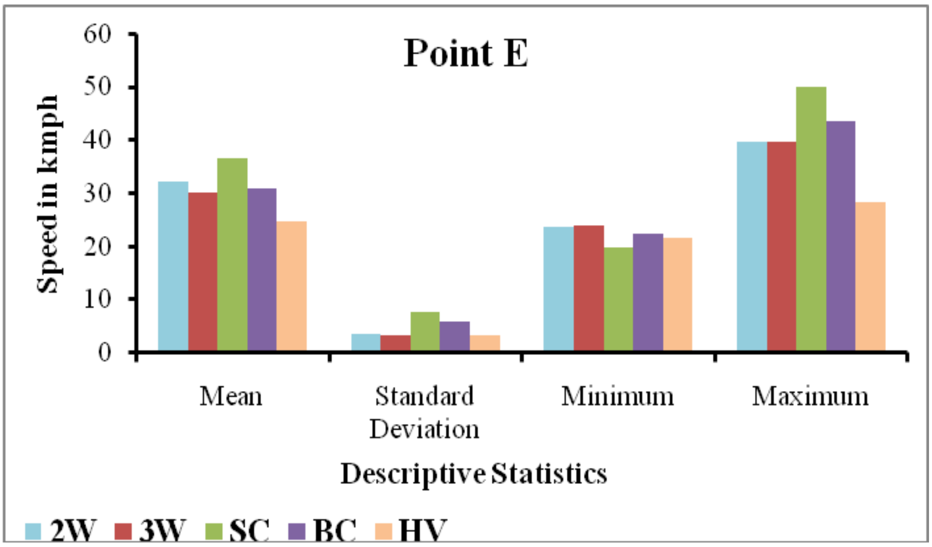


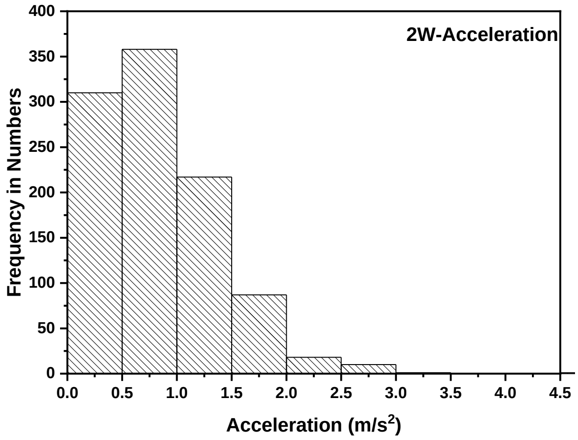
Figure 9(e) Descriptive statistics at point E

Figure 9 Descriptive statistics of speed at various points

From the above Figure 9 (a) it was observed that the mean approaching speed (U_0) at point A is nearly same for 2W, BC and HV but 3W and SC were seems to some at lower speeds. The speed at point B varies considerably for HV as seen in Table 2 the distance between point B, C and D is very low in case of HV. The speed of HV is about 85 % lower than the speed compared to other class and about 91 % lower with the speed compared to the U_0. Further the speed at point E (U_1) for the class except the SC was found to be 88% of the approaching speed. On the other hand it was seen that the SC regains its desired speed which was found to be 16% more than the approaching speed.

7 ACCELERATION AND DECELERATION CHARACTERISTICS

The acceleration and deceleration properties were analyzed for each class of vehicle in accordance with the respective acceleration and deceleration zone. The histograms were plotted for each class of vehicle for both acceleration and deceleration values as shown in Figure 10. Figure 10 (a) and Figure 10 (b) illustrates the histogram for 2W in acceleration and deceleration zone respectively with bin size 0.50 m/s^2. Similarly, Figure 10 (c) and Figure 10 (d) illustrates the histogram for HV in acceleration and deceleration zone respectively Figure 10 (a) shows that the maximum values of acceleration were ranging in between 0.50 m/s^2 to 1.00 m/s^2 for 2W and in Figure 10 (c) it ranges from 0 m/s^2 to 0.50 m/s^2 for HV. Similarly, deceleration values for both 2W and HV were ranging from 0.50 m/s^2 to 0 m/s^2. The descriptive statistics are also shown in Table 3.The results showed that the mean deceleration rate was high for BC and low for HV with values 1.43 and 0.70 m/s^2 respectively. Moreover, the maximum average acceleration value was observed for BC and minimum value for HV as 1.28 and 0.52 m/s^2 respectively. This analysis showed that the BC is having high average acceleration and deceleration rates as compared to other vehicle categories. Moreover, the maximum acceleration value was obtained for SC (6.47 m/s^2) and the minimum for HV (0.01 m/s^2). Similarly, the results show the maximum deceleration value of 6.1 m/s^2 for BC and the minimum deceleration value of 0.0085 m/s^2 for HV.



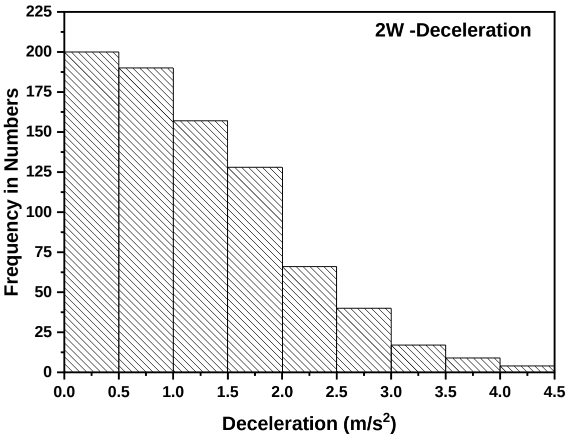
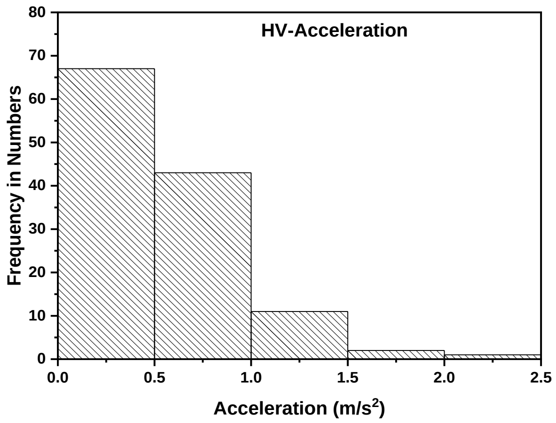


Figure 10 (a) Histogram for acceleration values of 2W Figure 10 (b) Histogram for deceleration values of 2W



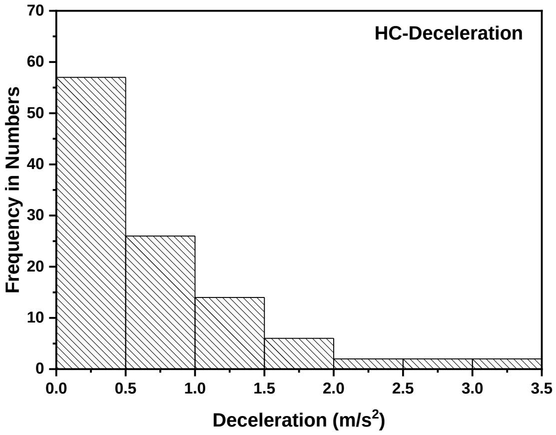


Figure 10 (c) Histogram for acceleration values of HV Figure 10 (d) Histogram for deceleration values of HV

Figure 10. Histogram for acceleration and deceleration

Table 3. Descriptive Statistics of acceleration and deceleration for various vehicle class

Property	**Vehicle class**	**Mean**	**Standard Deviation**	**Skewness**	**Minimum**	**Maximum**
Deceleration	2W	1.19	0.84	0.94	0.03	4.47
	3W	1.17	0.85	1.30	0.03	5.31
	SC	1.19	0.88	1.14	0.03	5.42
	BC	1.44	1.02	1.25	0.03	6.11
	HV	0.71	0.66	1.87	0.01	3.24
Acceleration	2W	0.82	0.55	1.15	0.03	4.50
	3W	1.07	0.85	1.69	0.03	5.67
	SC	1.25	0.89	1.34	0.03	6.47
	BC	1.28	0.91	1.24	0.03	6.25
	HV	0.53	0.40	1.38	0.01	2.30

8 STATISTICAL ANALYSIS

To evaluate the statistical difference between the acceleration and deceleration values for each class of vehicle one-way Analysis Of Variance (ANOVA) test was carried out at 95% confidence interval. The null hypothesis H_0 was assumed that the means for all the sections were the same and the alternate hypothesis H_1 that the means are different. The sample having p-value more than 0.05 was having the significant difference and thus the null hypothesis was rejected. Also if 'F' is less than '$F_{critical}$' the values are not the significantly different and the null hypothesis was accepted. From The results obtained from analysis gives 'F' value of 39.64 and '$F'_{critical}$ of 1.88. Thus the 'F' value is found to be greater than '$F'_{critical}$ which means there was a significant difference between the acceleration and deceleration values between different classes of vehicle.

9 SPEED DECELERATION CHARACTERISTICS

As from the statistical analysis, it is proved that values for deceleration are different among different class it is necessary to develop different models for speed-deceleration according to vehicle class. Further, it was observed that the pedestrian hardly cross the midblock section when HV is approaching. Hence, modeling for HV was neglected. The speed was found to be dynamic in nature which depends upon vehicle class, distance and time. Thus the vehicle acceleration and deceleration characteristics were analyzed with respect to the speed of each class of vehicle. The deceleration of the vehicle occurs for the avoidance of collision with the crossing pedestrian. The deceleration characteristics with respect to speed for various classes were shown in Figure 11.

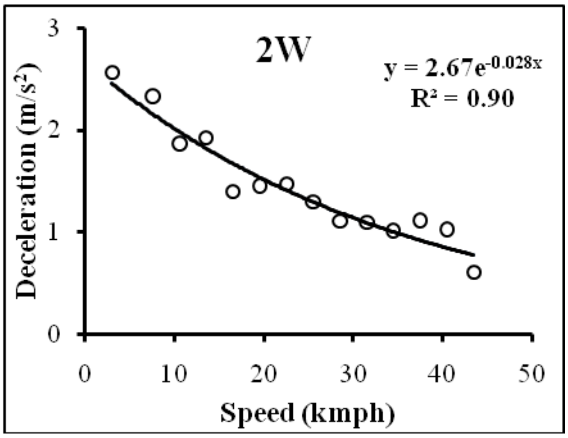


Figure 11 (a) Speed-deceleration for 2W

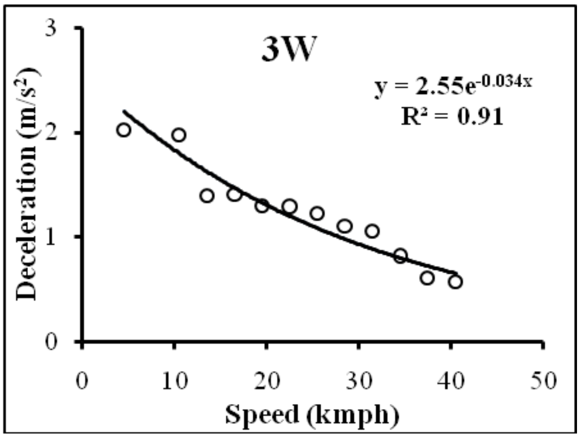


Figure 11 (b) Speed-deceleration for 3W

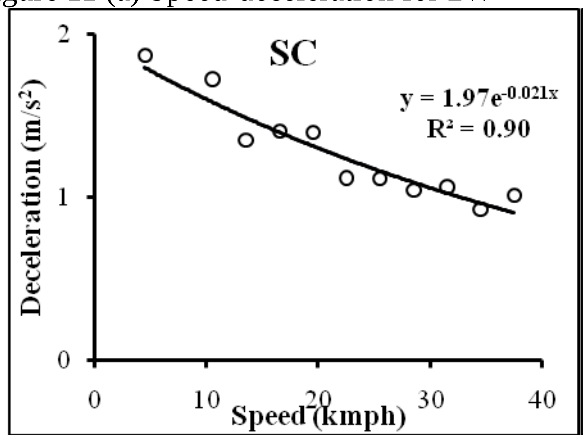


Figure 11 (c) Speed-deceleration for SC

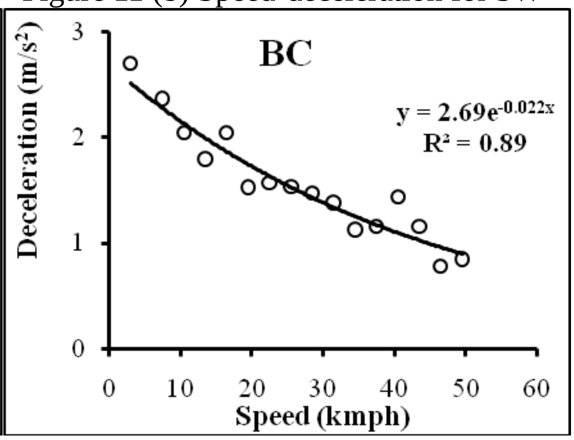


Figure 11 (d) Speed-deceleration for BC

Figure 11. Deceleration- speed profile

It was found that the exponential distribution was best fitted for speed- deceleration characteristics depending upon the maximum value of Pearson coefficient (R^2) which explains the variance of the distribution with the higher percentage. The developed models are capable of estimating deceleration rate for any category of the vehicle except HV for the given operating speed. All the models are well fitted having good R^2 value that shows models are sound good for predicting deceleration rate.

10 SPEED ACCELERATION CHARACTERISTICS

As the pedestrian hardly crosses the road section after seeing an approaching HV, the samples collected were very less and no more deviation was found in speed profile of HV. Hence, modeling of acceleration for HV was neglected. After the crossing of a pedestrian the vehicle accelerates back to gain its desired speed. The same analysis was carried out for speed-acceleration with the scatter plot and regression analysis. It was found that the exponential fit was best suited for acceleration also depending upon the highest R^2 value as shown in Figure 12. Here also the relationship between the speed and deceleration has been developed for each category of vehicles. These models are capable of predicting the acceleration rate for given operating speed for all category of vehicle.

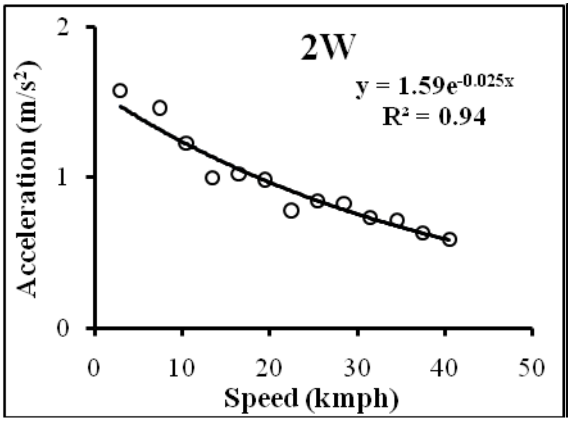


Figure 12 (a) Speed-acceleration for 2W

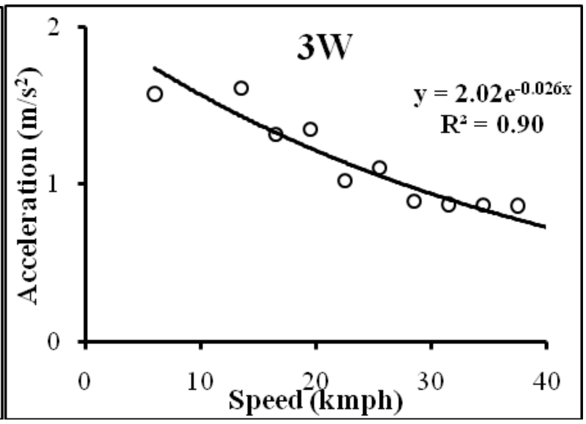


Figure 12 (b) Speed-acceleration for 3W

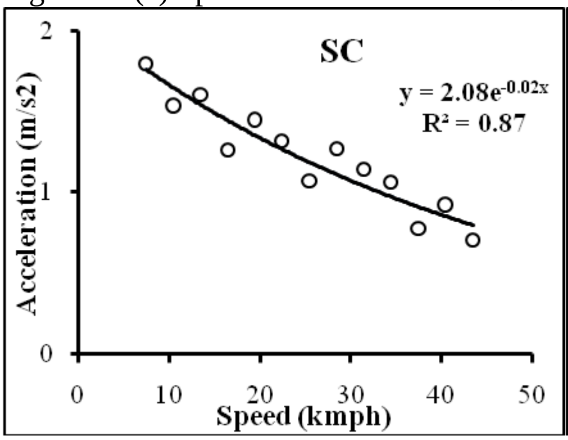


Figure 12 (c) Speed-acceleration for SC

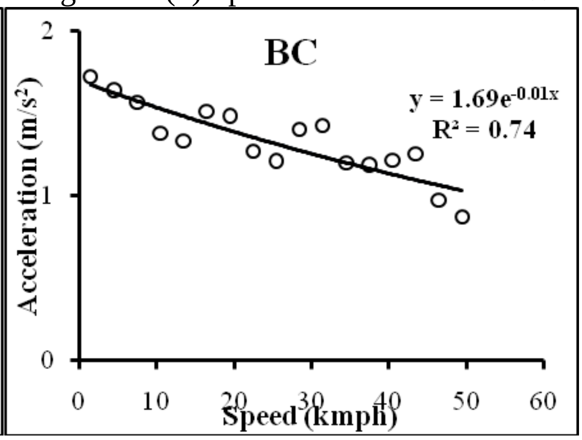


Figure 12 (d) Speed-acceleration for BC

Figure 12. Speed-acceleration profile

11 COMPARISON WITH PREVIOUS LITERATURE

The present study acceleration and deceleration values were compared with the previous studies which were done on freeways, signalized intersection, and ramps as shown in Figure 13. It was observed that the acceleration and deceleration values for 2W and 3W of the present study were higher than the values given at signalized intersection by Bokare and Maurya (2017). Furthermore, the values for the truck were found to be lower than the values given by Ahn *et al.* (2002) but more than the values reported by Polus *et al.* (1985) and Bokare and Maurya (2017). These variations seem to occur as in case of vehicle affected due to pedestrian the characteristics depends upon both the drivers' and the walking pedestrian rather in the case such as signalized intersection it is fixed signal and variation is also static. The perception of a driver who gets interacted with crossing pedestrian is to avoid the crash which is not the case in another facility like intersections, ramps etc.

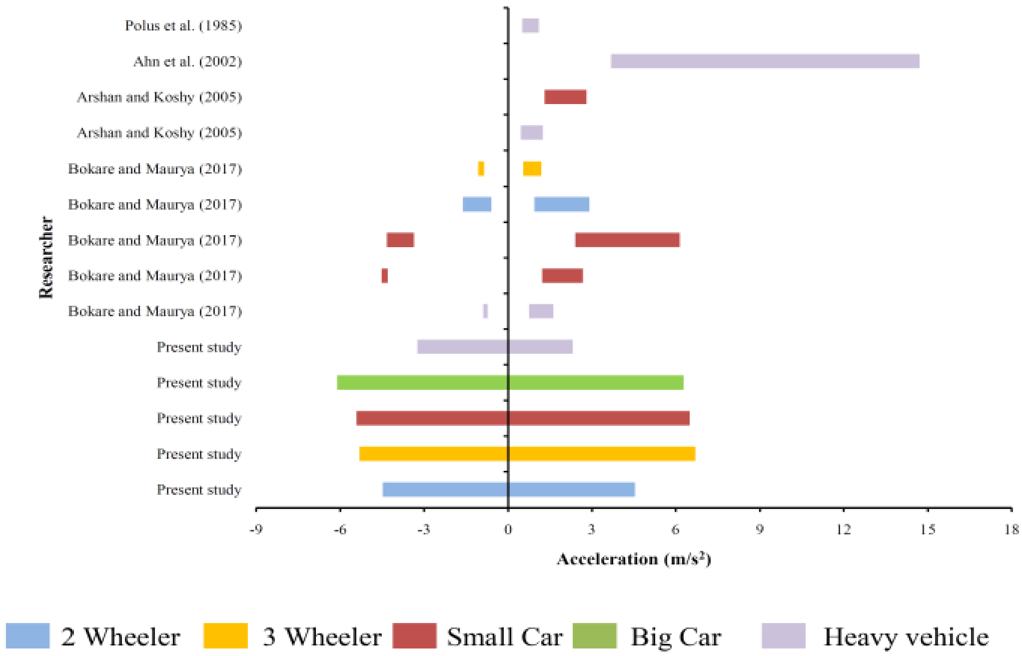


Figure 13. Comparison with previous literature

12 CONCLUSIONS

The pedestrian crossings from the crosswalks influenced the approaching vehicle as the vehicle has to decelerate to avoid the conflict. The pedestrians in the group can generally affect the more. This study overviewed the acceleration and deceleration properties of vehicles which get influenced due to crossing pedestrian. The study was carried out on the crosswalk in an urban area. The Performance Box was used for the study of instantaneous speed, acceleration, and deceleration characteristics. Five different categories of vehicles were considered for the present study. The results showed that the mean speed at point A was minimum for the 3W and maximum for HV. Also, the desired speed was found to be 88 percent of the upstream speed for all vehicle categories except SC. The mean deceleration rate was found to be the maximum for BC and minimum for HV with values -1.43 and -0.70 m/s^2 respectively. Moreover, the maximum acceleration was observed for BC and minimum for HV with values 1.28$m/s^2$and 0.52 m/s^2 respectively. Furthermore, the speed- acceleration and speed –deceleration relationship was found to be exponential.

The speed- acceleration and speed- deceleration relationships are further act as input for the simulation software which enhances the accuracy of the model. Also, the varying acceleration and deceleration values instead of constant values given by literature will be used for the precise overall delay estimation by incorporating acceleration and deceleration delay. These values will also be useful for the design of amber timings of signals for a pedestrian crosswalk.

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