

A Study on variation in fundamental diagram based on the effect of the gender mix conditions in Karnal Region

Rohit Biddu¹, Aman Bathla², Dr. Gurcharan Singh³

¹M.Tech Student, ²Assistant Professor, ³Head of Department
Civil Engineering Department, Geeta Engineering College, Panipat, Haryana,

Abstract: Study on the movement of an Individual Walker is possible in many ways such as data collection from the fields, Conducting Practical's in the controlled conditions or through various models. These are possible ways to study and understand the motion of a pedestrian, also its fundamental diagrams. The Impact of the different conditions on such diagrams can be simply study through the walking moment of the individual from the closed corridor conditions. For the better movement of a walker and an effective design for the various facilities, it will need to analyze the diverse angles and its effect on the human circulations. Therefore in this Research work it is tried to study variations of the fundamental diagrams which is based on the impact of the mixed gender conditions. It also aimed to emphasis on the behavior difference of the walker on the basis of the gender. For doing this test, human circulation under the closed boundary conditions of a corridor with different sets of gender mix conditions are chosen. From the research work it was determined that the average free flow speed of an Individual whose gender is male is about 1.27m/s and female have average walking speed of about 1.24 m/s. It is noticed that female pedestrians are more concern for their private spaces. But this is not proved through the stats up to now. In this thesis we have tried to conduct a hypothesis whose stats results may help us to comprehend the gender mixed conditions more accurately and clearly.

Keywords: Signalized Intersection, Design Speed, Signal Volitions, and Crossing Behaviors, Mixed Traffic Conditions.

I. INTRODUCTION

In Transportation System Walking is perhaps, one of the Oldest among all other available modes.

- a) It is basic and necessary mode of transportation chain which is used by each and every person on the Earth. Walking also assist the outings of all other modes, that is whatever is the way one like to choose for travel, the Initial and final mode will be walking. It is the cheapest mode available for the Transportation of people which have minimum disturbance to the surrounding environment. As per the definition of UVCP. "Any person at foot is known as Pedestrian". This includes Person with Physical disabilities also, like wheel chair users or any other kind of assisting devices. It is observed that in all the aspects, more priority has been given to Motorized Transportation than the pedestrian flow. But in many factors pedestrian motion has an important role such as (a) In the Planning for the land use of an area, (b) for the effective & efficient management of the flow of traffic and its forecasting (c) For designing significant facilities for the public places. Unidirectional movement & bidirectional movement are two ways in which a pedestrian moves. The flow of an individual in single direction only is called as uni direction motion of the pedestrian. Similarly when the flow of the Individual walker is in both directions is termed as bi directional movement. By understanding the pedestrian motion or crowd dynamics one can make mobility effective and safe in most populated regions. As per the DEMOGRAPHY, India is on the 2nd place in Population, having 1.27 billion people. The contribution of this number to the world is about 1/6th which is a total of 17.6% of the population of the world. In Previous two decades because of improvement in socio- economic conditions in India, we have witnessed a high level of movement at city centers and intercity segments. In a study conducted on the Mumbai City of our country it was concluded that from about 30 lakhs trips 52.5% are on walking mode. The cities of Africa shares more walking trips from other countries. From the Africa, Asia and America, Asia shares about thirty seven percent of the walking trips. In a Research conducted on the Beijing city of china it was concluded that 15% pedestrians were moving towards the transit station, 10% were walking for the recreational activities, 23% were walking for work purpose, 15% for school & 23% for shopping which is about 61% of entire trips. With the fast growing population and crowd on the roads, the need of the adequate pedestrian facilities is also increasing in the urban centers. In the vehicular motion, one will have to follow proper rules and regulations that the authorities have laid down. Also traffic flow is separated by different lanes and it is mostly unidirectional for particular lanes on highways. On the other way pedestrian flow is complex and cannot be measured under one category. This flow is mostly in multidirectional. The distance between the two pedestrian plays an important role and effects there speed. For a designer the understanding of the nature of the Walker on the road is significant for the effective design of public facilities such as side walkways, crossways, subways etc. The adequate design and Planning of these facilities is also very important to provide sufficient Space for the free movement of the group of people. With the fast growth of the vehicles in the whole world Environmental problems are raising rapidly, walking is an alternative to reduce such problems. Physical health is also an influencing factor for walking. Walking play a great role in keeping the one physically fit. While planning a facility for walking, Safety and security of pedestrian is a big issue at poor visible points where vehicle- pedestrian could clash with each other, such as at intersections. A poor facility may results in more accident circumstances. A lot of problems are being faced by pedestrian and a car driver on busy roads. Darting is one of such problem which reflects sudden appearance of pedestrian in front of vehicle. Dashing is another problem refers to running Pedestrian. According to a study children having age group less than 14 years are the one forming a list of more number of accident victims who have highest rate of injury. The fatality for older group is more because of less chances of recovery from such injuries. Also the nature of Walker may be affected by alcohol or any kind of intoxicating drugs. Seeing all this it is significant to adopt a better Facility System which should fulfill the purpose of backing a pedestrian both in physiological and psychological manner and

assure them against any overexertion or mischance. This is the reason because of which in early decades a large number of research and study has been started in this area of Transportation System. Samples are usually taken at such locations where volume of walkers is more in numbers against the density. The point like Business locations, Group of people coming out from theaters and stadium doors at Same time malls etc. In this thesis we have tried to study on the common behavior of an individual on the basis of their gender. This can be done by studying the movement of walkers empirically by conducting different types of experiments like bottle neck, single file, flow through an open space etc. The Co-relation between speed & space study of walkers is helpful to understand the affect of space in between two or three pedestrian in the direction of flow. This can be study by conducting single file and bottle experiment.

- b) Due to the different geometry of the hall, two dimensional variations can be observed in the speed- density relationship of crowded flow, when flow through open corridor experiment is conducted.
- c) By Conducting a test on Evacuation of the pedestrians from a mall, theaters subways etc one can observe the choices they make and the Impediment in the path they follows.

In this work, a test named as single file is carried out on the movement of the Individual Walker to get information which is related to the impact of room between two pedestrians on their relative velocity in the direction of their movement.

Represent appropriate relations which are further utilized for evaluating or designing the stereotype of pedestrian movement. This is also an important test to study the suitability of the stereotypes of walkers movement for selection of final Portrait. In this dissertation, it is tried to study the effect of the gender on the mixed condition of traffic flow by using these Fundamental Diagrams. The Velocity, Density etc, are considered as the principle Variables of the Traffic Streams and hence the correlation among all these quantities is termed as fundamental relations of pedestrian Stream. The representation of the Principle variable can be done by using some plotted curves which is termed as the fundamental Diagram of Pedestrian Stream. These Diagrams are plotted on suitable measures by empirical studies and practical observations

II. LITERATURE REVIEW

Older S et al [1] researched on the movement of the Pedestrians flow in busy shopping streets. He put his efforts to make a correlation among the velocity and density of the Pedestrians in three separate locations of shopping streets. From his studies, he came to a conclusion that as predicted, the change in density affects the velocity of the moving pedestrian. He observed that the fast moving pedestrian has to slow down on the increase in density, but it has less affect on the pedestrians who are already moving slow on the streets. This ultimately affects the range of the velocity of Pedestrians which is less as compare to earlier. In his research he also concluded that during the situation of congestion, most of the pedestrian was leaving footway and started walking on the pavement of the road. The different correlations like Velocity-Density or Density-Stream are quite different in both these locations. In his test he also observed that for the same densities of pedestrian at location First, which is slightly narrow, the velocity of the Pedestrian is more in comparison to the location second of broad and wider size. Hankins et al [2] also researched on the stream of Pedestrian in subway and all blockages involved. These constrictions involve Stairs and corners, study of which will further help in the design of the new pedestrian facilities. Also he made a non linear graph between velocity and density. Through his research he came to a conclusion that the movement of the Pedestrian on the staircase is very much less than the pedestrians moving in the Subway. During the complete operation the stairs are producing bottlenecks in the flow of the Pedestrians under high densities. Also when the subway is fully packed with the pedestrians there is an insensible reduction in the speed to avoid any kind of distress circumstances. Ultimately there will be no such practical improvement in the flow of the pedestrian stream. Hoel [3] also done his research on pedestrians flow. In his study

he focused on travelling rate of the pedestrians from the various central business places. He analyzed that these travel rates get influenced by atmospheric factors such as the time on that day, outer forces, temperature etc. He also concluded the fluctuations in these travel rates on the basis of the gender. Oeding et al [4] has done his research to comprehend the attributes and deportment of the Pedestrians in the mixed flow conditions. He made correlation between Velocity flow and density of distinct type of pedestrians such as the Pedestrians at shopping places, people walking to Work places etc. Navin et al [5] also conducted his research on the flow of the Pedestrians and observed that pedestrian experiences a difficulty on moving in two way flow. **Daamen et al** did is study on the various group of the pedestrians to conclude its quantative consequences. He focused on the pedestrian's direction, their free velocity, density etc. He Conducted his Experiments at bottle neck points and comes to the conclusion that at such narrow points pedestrians avoid to walk parallel to one another and follows a new effective pattern like "zip" for their comfortable movement. Also in their studies they concluded that when these pedestrians had less space in between at bottleneck points, their approach and movement towards the exit was suddenly more and they preventing the other pedestrians to not to use the available space between them. **Isobe et al** did their research to get the efficient out comes on the counter flow of the pedestrian. They were seen as the only one for differentiating the experimental consequences and the simulation outcomes of the pedestrian counter flow. They analyses the various variables of the pedestrian counter flow, such as the velocity of pedestrian movement, the pattern for the motion, jamming transition etc. **Helbing et al** performed a lot of the tests at the intersections of pedestrian facilities, corridors of public buildings and important bottleneck places. There were a lot number of persons involved in his tests. While his research he concluded that the elements of the facilities provided for pedestrian service have a real connection with the geometric end conditions. He also concluded through his test that these boundary conditions have a good relevance to the time space pedestrian's dispersion. Hence it is concluded that pedestrian has self organization ability, when they move through less space. In addition to the study evinced that if any barrier exists will be helpful in solidifying the stream pattern and such hurdles will be useful for increasing the

pedestrian's flow fluidity

Various flows which meets at same point at an instant of time can be well managed by using the method of narrow contour band routes at movie hall, Auditorium etc in order to minimize the waiting time of the people and also the shock waves when the density is very high. They come to a inference that the shock waves in the dense and panic crowd can be minimized by using the geometry of zig zag shape very soon after few years. Daamen Hoogendoorn and their team

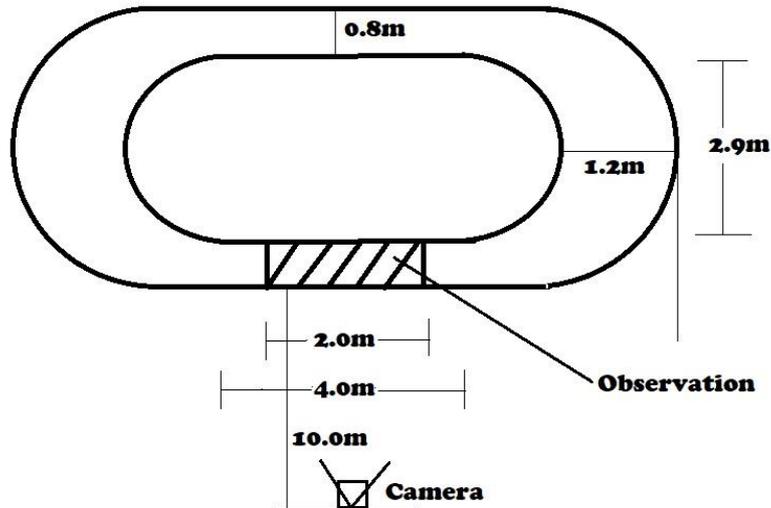
Conducted some tests to evince the accuracy of the first order traffic flow theory. Several tests were conducted for two dimensional pedestrian stream operations at critical locations. Later Daamen and Hoogendoorn conducted a test to evince the accuracy for the first order traffic stream theory which narrates that at the most dense bottlenecks regions where there are gathering of large crowd, two dimensional flow occurs. Navin et al analysed the differential speeds of the pedestrians and noticed that the female pedestrians have less walking speed than the male pedestrian. **Henderson et al analysed** in his studies that men and women are always there in all the pedestrian groups. He also concluded that their difference according to the Gender is quite difficult because it was thought that for making it possible there should be uniformity in all activities and surroundings. Also along with this attention will have to be paid for selecting their ages. **Henderson et al** used the theory of the gas given by Maxwell Boltzmann to the flow of the mixed crowd of the male & female pedestrian. In his research he worked on the Important conditions like the gender and the various Challenges for determining the important distort of the pedestrians. In his study he concluded that the distort is not exactly related to the various Challenges. The average velocity was varying with the changes in the Challenges. He also concluded that female pedestrian's experiences more challenges than the male pedestrian. **Morall et al** noticed that male pedestrian has more speed while walking than the female pedestrian. The speed variation was about 3 m/min between the two genders. **Hoel et al (1968)** studied the travelling rate of the walkers in the Business places. Also he analyzed the frequency distribution of the velocity of the pedestrians. In the research work, he concluded the various environmental conditions that can affect the flow of the walkers like the external affects particular time for that day etc. Also he analyzed the frequency distribution of the velocity of the pedestrians. In the various environmental conditions that can affect the flow of the walkers like the external affects particular time for that day etc. Also he analyzed the variation in between the men & the women rates. **Hankin and Wright (1958)** studied the speed of the school boys at per square foot. They established a correlation curves between speed and density. The test was conducted at the London shopping areas particularly on the subways and the Public stairways. **Oeding (1963)** in Germany analyzed the motion of the pedestrian on the basis their trip purpose and found the correlation between the speed flow of Pedestrians.

III. RESEARCH OBJECTIVE

The problem for this research work is to understand "Variation in fundamental diagram based on the effect of the gender mix conditions". In this work the movements of the Indian individual is analyzed to understand the variation in the fundamental Diagrams based on the effect of the Gender mix conditions" by using single file Test.

IV. METHODOLOGY AND DATA COLLECTION

The table, chair and plastic ropes were used to make the test setup in circular plan. The Geometry of this setup is similar to the experimental setup of Chattraj et al (2009) for conducting the same test in India. In a closed Circular plan, a corridor is made of geometry as shown in the figure 3.a to conduct the test. The Experimental was done in the College's hall in the morning time in good weather conditions. The total longitudinal distance of the passage way is 17.4 m (L_{np}). The regions of the test setup where the information was collected and is shown in the figure as shaded portion and is termed as observation portion. Despite this point that the pedestrian will walk around the circular path provided to them, the observation portion is restricted together the required information. The portion of the observation part has a length of 2m [L_{no}]. This part is restricted between two ranging rods at the section. For gathering the information correctly a camera which is an important part of the experiment was set up at about 10 m distance on the perpendicular bisection of investigating portion. This is done to reduce the parallax error while conducting practice. The lateral distance of the way along the longitudinal area is restricted 0.8 meters for assuring the single file flow only and minimizing the chances of passing one another or walking besides each other. For the arched portion the same lateral distance is increased to 1.2 meters. The reason for expanding this region is if the width will remain same as in the other parts of the setup, the speed of the pedestrians may decrease which will affect the end result of the experiment. While conducting the experiment it is kept in mind that the ground is almost clear from obstacles. The students of the College are the subjects for making it possible to conduct this test. All these students demonstrated all the important precautions they need to take while walking in the flow for collecting this information in different possible densities. There are 7 different groups made to conduct this test. These are when number of persons are $S =$ one, six, twelve, Eighteen, twenty four, thirty and thirty six.



All the subjects either male or female are first allowed to walk consistently in the test area in a steady flow. Each and every subject provided with instructions and the direction to start and ends after three rounds of the corridor. Further an exit point is made for exiting of the subject outside the corridor. They need to walk up to sufficient distance after leaving the corridor so that there is less chances of tail back effect. These subjects are students of nearby college include both male and female gender in it. The test is conducted as per Indian standard design and hence the direction of the flow is as chosen anti clock wise. Five types of groups were made to conduct this Experiment these are:-

- 1) Males only
- 2) One female and two males
- 3) One male and one female
- 4) One male and two females
- 5) Females only.





STUDY OF EMPHERICAL DATA & CONCEQUENCIES

This section refers to the examination of the data collected and to depict the consequences of the gender mix effect on the Indian Pedestrians. The results obtained are divided in to five parts. The basic correlation of the elements like speed and density, speed, headway distance etc. of the pedestrian movement is depicted in the first and second section. The next section shows the free flow velocity of an Indian person on foot. The section fourth of this shows the analysis conducted by hypothesis testing. The last section shows the ANOVA test to differentiate the uniqueness of the entire test conducted.

Velocity - Distance Correlation:-

The various fig. D-1, D-2, D-3, D-4 & D-5 portray the correlation among the physical quantities like the velocity and the density for all the various types. Velocity and density correlation is the fundamental data needed for making the fundamental diagrams for the pedestrian flow. The velocity and the density of the various groups of the pedestrian were taken in the closed corridor for this test. The various groups are

- a) For all male
- b) 2-male & 1-Female
- c) 1-male & 1-female
- d) 1-male & 2-females
- e) All females

From the study it was experienced that when the density was showing a growth, at the same time there was seen a decline in the velocity and when it was showing fall in its value, the velocity was at its maximum value. From the given graph it was analyzed that the correlation among these two physical quantities has a non linear behavior.

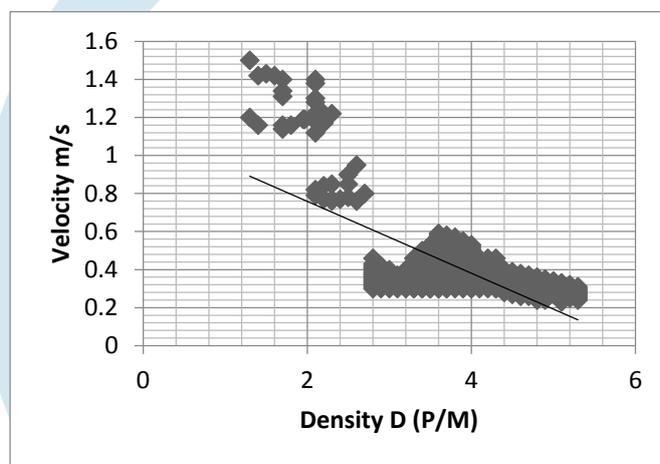


Figure 4.a Velocity- Density for all Males

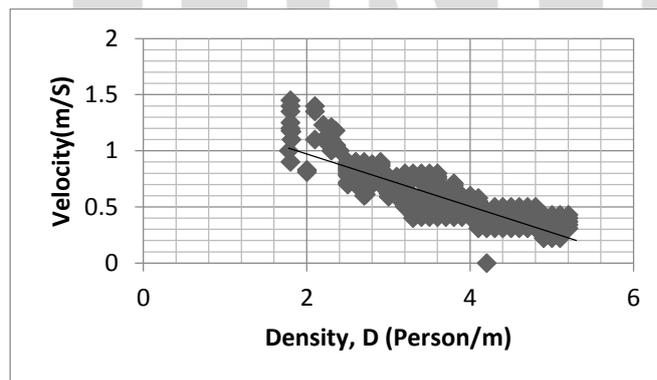


Figure 4.b Velocity- Density for two male and one female

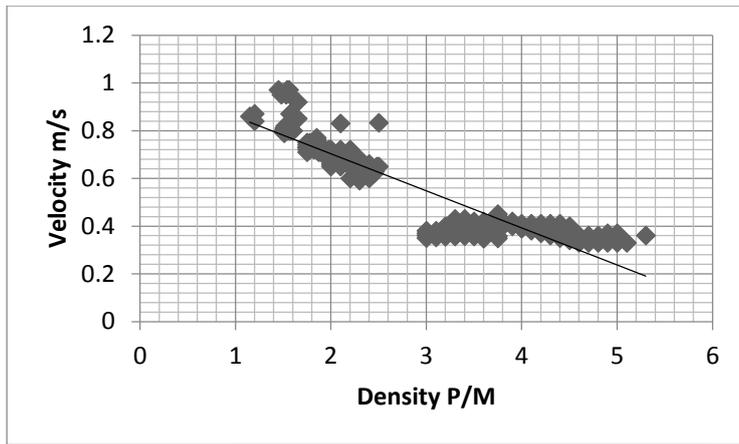


Figure 4.c Velocity – density for one male and one female

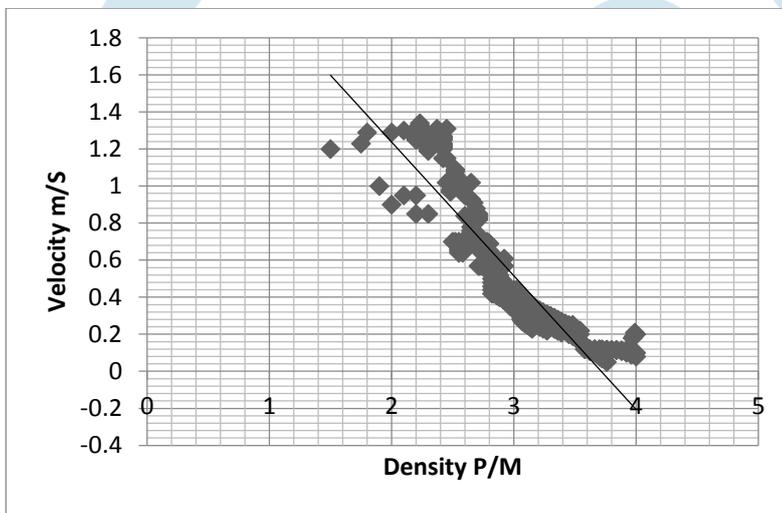


Figure 4.d Velocity density for one male and two females

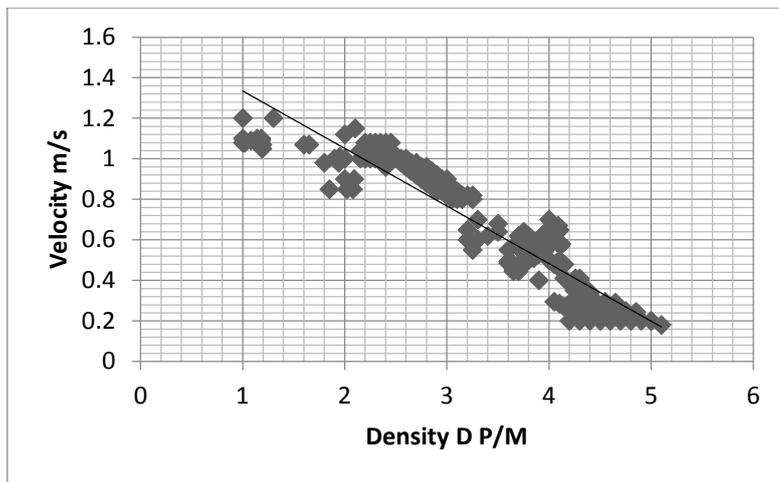


Figure 4.e Velocity- density for all females

C

Distance headway and velocity correlation:-

From the fig. given D-6, D-7, D-8, D-9 & D-10 the correlation among the distance headway and the velocity of the pedestrian was shown. From the previous graphs it was clear that the relationship between the two physical quantities i.e. velocity and density has a non linear behavior. So instead of the density of a pedestrian, the distance headway of the pedestrian was counted by inverting the data collected for velocity. As it is required to have a linear relationship graph to fit for the statistical analysis, therefore the graph between the distance headway and the velocity relationship was chosen for the further research. The data for these two quantities were accumulated in a closed corridor condition. There were number of tests conducted for this data, these are:-

- a) All male
- b) 1- Male and 1- female
- c) 1-male and 1 female
- d) 1-male and 2 female
- e) All females

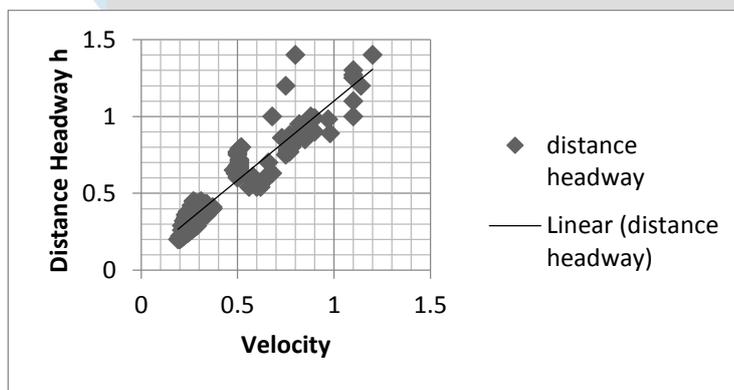


Figure 4.f Distance Headway- Velocity plot for all males

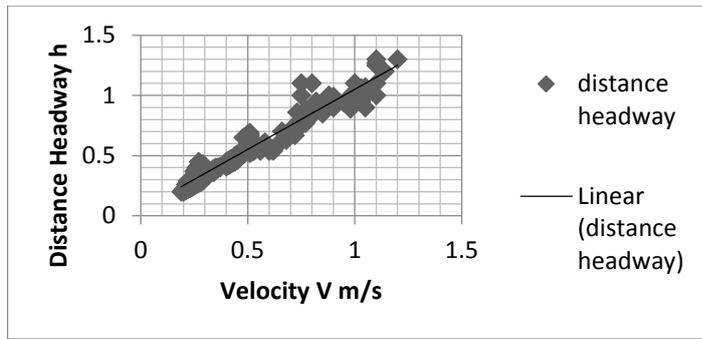


Figure 4.g Dist. Headway- Velocity plot for 2 males one females

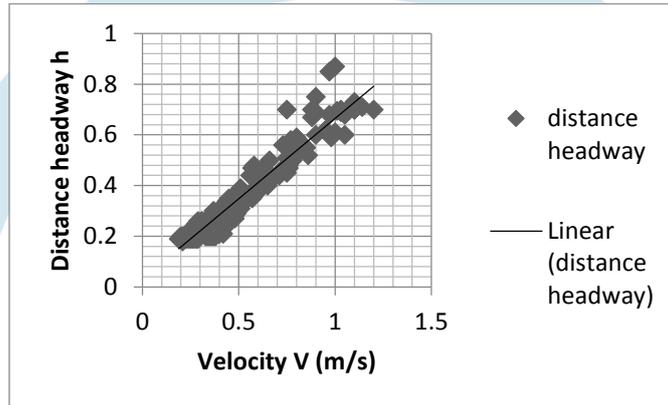


Figure 4.h Dist. Headway- Velocity plot for 1 males 1 female

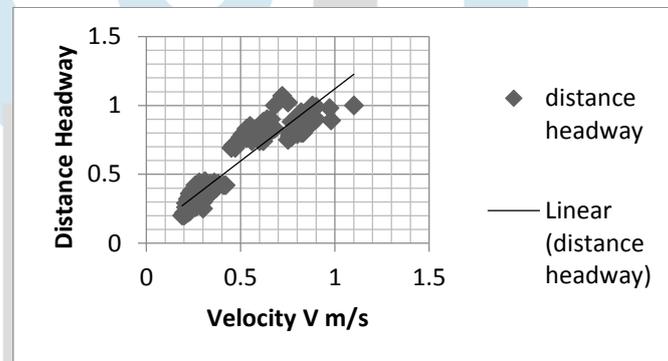


Figure 4.i Dist. Headway- Velocity plot for 1 males 2 females

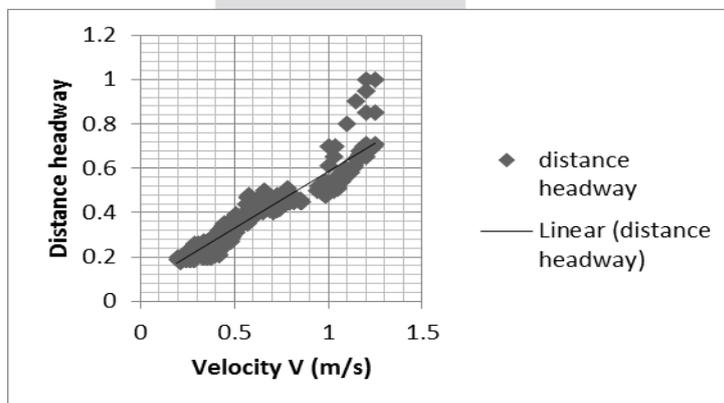


Figure 4.j Dist. Headway- Velocity plot for all females

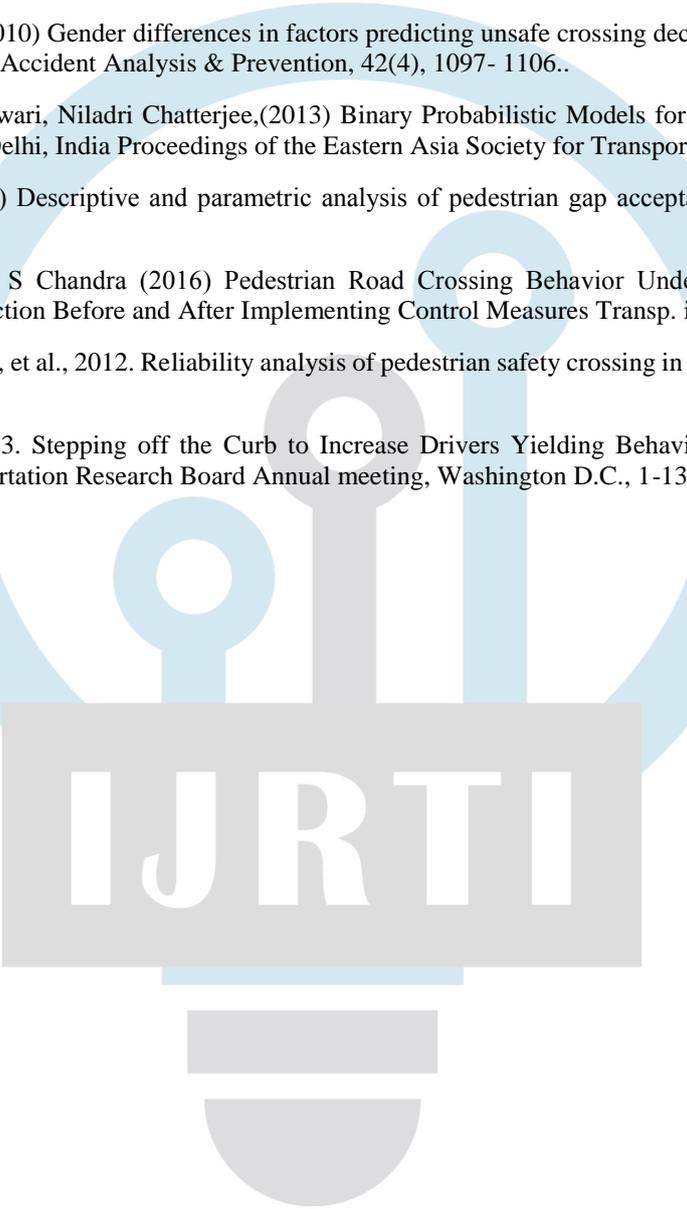
CONCLUSION

The research is done by conducting single file experiment under the restricted area conditions on the movement of the different groups of the pedestrian to understand the effect of the gender mix on the crowd dynamics. The main aim of this research was to depict the effect of the gender mix on the basic diagrams of the pedestrian flow through hypothesis. The outcomes of the experiment were observed and relationship between different quantities was found by using Z-test and Anova test. The outcome of the experiment was as under:

The average free flow velocity of the male subjects was 1.27 m/s and for the females the velocity is slightly less i.e. 1.24 m/s. During the free movement of the pedestrians the females are more concern about the free space and distance headway than the males.

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