

IMPACT OF GENDER AND GENDER MIX CONDITION ON PEDESTRIAN FLOW DIAGRAM

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Abstract: A study of pedestrian activity may be conducted through multiple methods, including walker's movement investigation (field data collection), experimental tracking and controlled research and the development of pedestrian models. All of these various kinds of experiments are subject to simple diagrams. The best solution to understanding how the multiple situations affects the fundamental diagram is to shift a pedestrian down one corridor line under closed boundary conditions. The aim of this research is to analyze the influence of the gender mix on pedestrians at various densities at the fundamental level. The key contribution to the study is to investigate whether it is feasible to use a preferred diagram, whether it is the effect of gender mix conditions on foot movement. For the experiment, five separate gender mix conditions are selected to execute the simplest system known as the pedestrian movement along a line under closed limits (Single File Movement). The average free flow rate has been estimated to be 1.27ms^{-1} for men and 1.24ms^{-1} for women. When women travel, they are more mindful of their private space than men. That may be attributed to inconsistencies in their autonomous behavior. You can't assume whether there are contrasts without any statistical data. By way of statistical hypothesis checks, quantitatively, these discrepancies remain, recommending in fundamental map that the gender and gender combination be affected.

Index terms: Pedestrian accident, Hypothesis check, Fundamental diagram, Z value test.

I. INTRODUCTION

Walking might be the most helpful, essential and fundamental transport device open to society and utilized by almost all of the world's people. The route is often used on several separating walking journeys. Regardless of the simple form of transport, walking is typically the first and last mode used, offering a fundamental link mechanized transport between region use. It is also sound, inexpensive and environmentally sustainable. India's population says, with its more than 1.35 billion citizen and 6th of world's population and is also second most crowded country on the globe. From now on the population will be 1.38 billion in 2020. The most crowded country in the world is projected to be the world's population, which would overtake china, so that India should be equipped with sufficient facilities for better architecture and movement of people and to empower and promote walking for distinctive purposes. That is why exploration of streams of walking movements in the last couple of decades has been minimal. Since walking is part of the transport chain and no progress is feasible without it. For example, one has to go to reach the main road and take a vehicle, people walk through inland township, centered commercial areas and malls, party discharge, stadiums and games and in the midst of festivals. This work seeks to empirically research the actions of the Indian population on their basis consideration of gender. The pedestrian's motion can be analyzed empirically by carrying out various tests, such as single file motions, flow through open hallway, experiment with the bottleneck and hall elimination etc.

II. LITERATURE REVIEW

Hankin et al. [1] examined passenger movement in subways and the influence of constraints like stairs and curves. They have a speed density non-linear graph. You found movement on stairs considerably less than on underground and stairs, which is why bottlenecks will form in the passenger's completely loaded movement scheme. When a metro gets more packed, the innate instinct not to step over the person's heads contributes to an oblivious slowing down. This results in an efficient mane calculating flow over which increased A lower pace is offset for the crowding (and consequent discomfort). The experiment in order to consider the feet and function of mixed transport condition was formed by Oeding et al[2]. and described the correlation of flow and density for various forms of pedestrian shopkeepers, including shoppers coming or going to meetings with people who work etc. Older et al. in front of shopping streets examined foot traffic. There was a link between the pace and density of footpath walking in three separate locations of shopping paths, and it was observed that the increased density would decrease rather than slower the speed of rapid pedestrians, thereby decreasing the speed of the pedestrians. He also took into consideration the impact of crowd and observed that people are more inclined to move along the car when the footpath gets busy. The measured speed/density and flux/density

ratios at these two positions were both found to be somewhat different. Site 1 where the footpath is small has the same densities, the pavement is more effective than site 2 and pedestrians on the narrow foot path have a wider usage than those on the wide one also, it let to understand road infrastructure problems and pedestrian behavior on road. Daamen et al. [3] conducted a laboratory experiment on pedestrians to get qualitative results. They considered the variables like, free speed, walking direction, density and bottle necks. They found that within a bottleneck pedestrian do not walk next to each other, but “zip” in an efficient way and they also found that, when pedestrian come closer to the bottle neck, they try to reach the bottleneck more actively prevent other pedestrians to use the available empty area to quickly pass the bottleneck. Seyfried et al. [4] on unidirectional pedestrian flow through bottlenecks. It was found that the flow and the width hold linearly depend on each other for different types of bottlenecks and initial conditions. The minor influence of exact geometry of bottleneck on the flow was also found by comparing the different kinds of bottlenecks and lengths. Chattaraj et al [5]. conducted an experiment on pedestrian streams in corridors to compare the fundamental diagram of pedestrians across culture and found that Indian test person’s speed is less dependent than Germans test person’s speed on density. And the unordered behavior found more in Indians which is more effective than the ordered behavior of the Germans. Chattaraj et al. [6] Developed a modified Blue-Adler model which described the fundamental diagram of pedestrians of different cultures. He also described the differences exist between people’s perception of space in different cultures according to the modified Blue-Adler model. Navin et al [7]. Studied the distribution on pedestrian speeds while considered the pedestrian flow characteristics and found that the women walked slower than men. Morrall[8] studied that walking speed of men and women and observed that walking speed of men faster than women and also walking speed of men were 3 m/min faster than women.

III. MOTIVATION

As we discussed in literature review, Review shows that how many studies are performed to get the relationship between velocity and density and their interrelationship. The motivation is simple as we know that the population of the country and if they buy more vehicles it will cause more congestions and more accidents will happen so to avoid these situations, we have tried to crack the walking pattern of pedestrian by taking a corridor and also check how

geometric features of corridor will affect the walking pattern of pedestrian. So, the main objective of thesis is to observe the impact of gender and gender mix condition on pedestrian flow diagram.

IV. EXPERIMENTAL SETUP FOR SINGLE-FILE MOVEMENT

There are wires in the experimental corridor. For related studies in India, Germany the type of the experimental Corridor is similar to that of Chattaraj and others (2009). But the scale of the experimental setup is not same as it was mentioned in Chattaraj here geometric features are changed to study the impact. A closed, size and form corridor as shown in Figure 3.1 is built and used. This test was conducted in glorious weather at mid-day. The passage volume, $lp = 19.3$ m. Despite the passage of walkers along the corridor, the knowledge is obtained only in the shaded portion, defined as the observation segment as seen in Figure 3.1. The observer segment length, $l_o = 2.5$ m, is constructed Raise two running line on the segment and cut lines from the observation region. The cameras were positioned on the perpendicular bisector of the observer region at a distance of 10 m from the observational section, thereby minimizing parallax error. The width of the road on the right is 0.8m and is suitable for the movement of the single file but not for overtaking. In the curved segment the width across the elliptical transit curve is extended to a height of 1.2 m. The explanation behind the expansion in the curved section is that a curved 0.8 m broad section will minimize unnecessary speed. The analyses are administered on a flat pitch. Themes involve students of SGSITS college. The topics can never be resolved or otherwise moved. To collect data at various densities, seven arrangements of experiment with number of subjects $N = 1, 5, 10, 13, 18, 20, 25$ are performed.

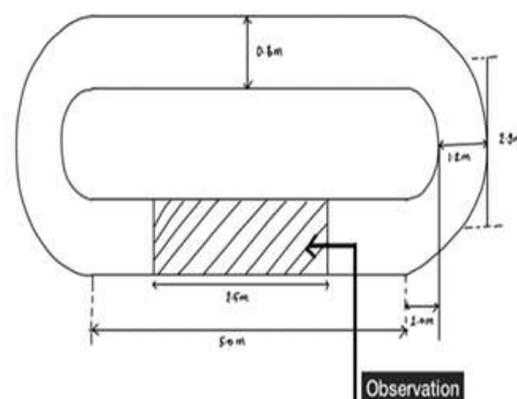


Fig. 1: - Experimental setup

All participants used as part of the cycle for this experiment (except for $N = 1$) were at first constantly distributed across the corridor in steady progression. At this point, every subject is given three times the

way to continue. After that the closed corridor from which subjects are permitted to leave and start to walk away from the crossing for sufficient distance to avoid a tailback effect. The experiment participants included both men and women. Depending on the type of Indian architecture, the movement of the experiment was anti-clockwise. The experiment was conducted in five separate groups to show the gender and gender mix situation. The five different categories taken into account are:

1. All Males
2. Two male and One female alternatively
3. One male and One female alternatively
4. One male and Two female alternatively
5. All Females

Figure shows the snapshots of the experiment and this experiment setup is taken from Chattaraj, Seyfried and Chakroborty.



V. DATA COLLECTION

In the first position to gather the velocity-density details, a camera is used to collect the data. In the test two lines are drawn to locate the rectangular calculated section shown in fig 3.6 From the video data as shown in fig, the snapshot of the observed segment is located. To gain the crossing period of each person (say person p) from the rectangle area, passage time (t_{in}) and way out time and (t_{out}) are noted.

So, from this data we can easily calculate the velocity of an individual pedestrian. After that density is also calculated from this data. Pedestrian walks in this

experimental corridor very slowly and there is no overtaking and pushing so the precision was accurate at the time of information gathering. For the calculation of space headway, It was very easy to calculate. It is inversely proportional to density.

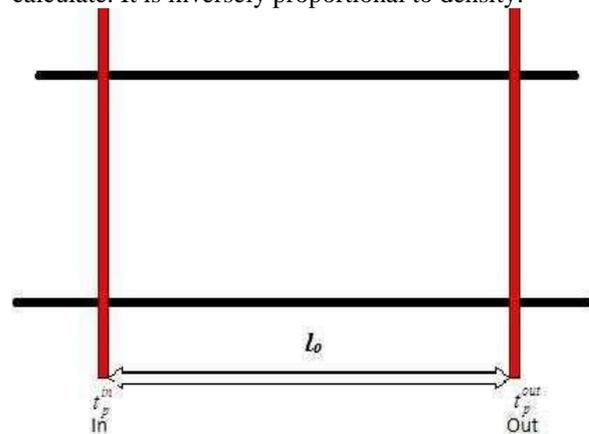


Fig. 2: - Observational portion

VI. ANALYSIS OF EMPIRICAL DATA AND RESULTS

To show the impact of gender and gender mix condition in India, this data is analyzed and described. After finding the results these results are split into four categories. First one shows the velocity and density relationship and second one shows the relationship between speed and space headway and third one shows mean free speed of pedestrian and last one shows to mathematical research by checking hypothesis.

VII. SPEED-DENSITY RELATIONSHIP

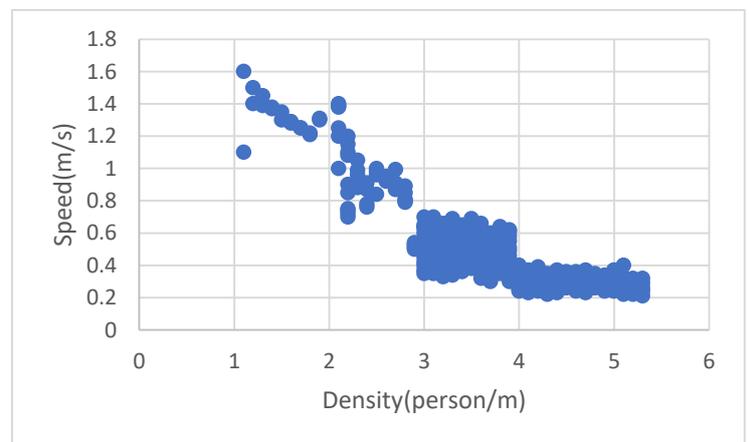


Fig 3: Speed-density graph for all male condition

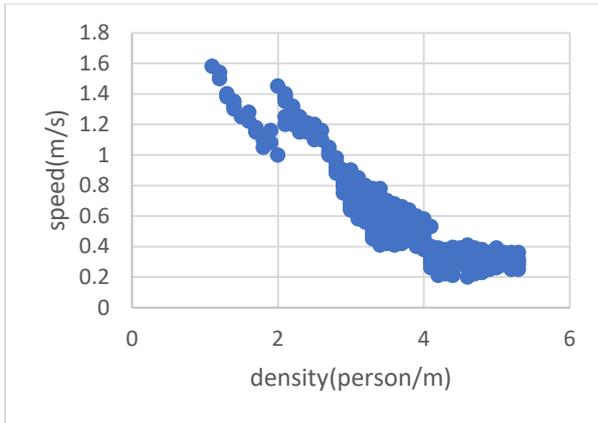


Fig 4: Speed-density graph for two male and one female alternatively condition

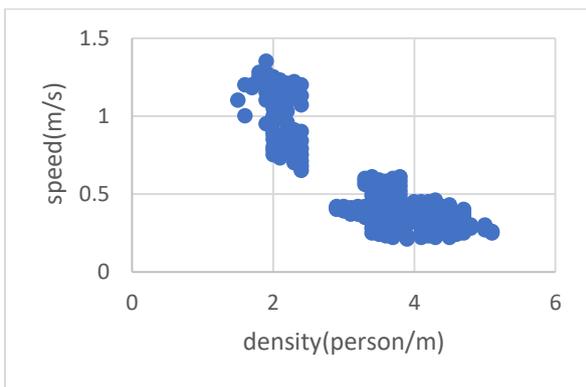


Fig 5: Speed-density graph for One male and one female alternatively condition

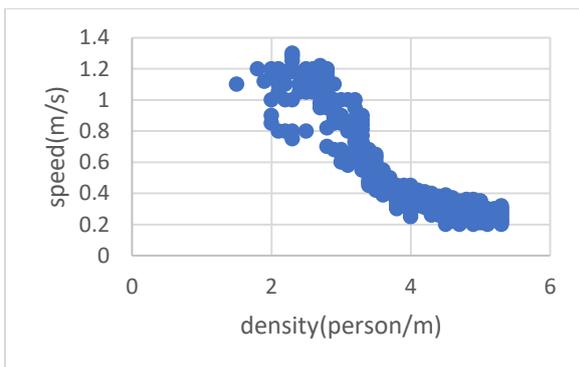


Fig 6: Speed-density graph for one male and two female alternatively condition

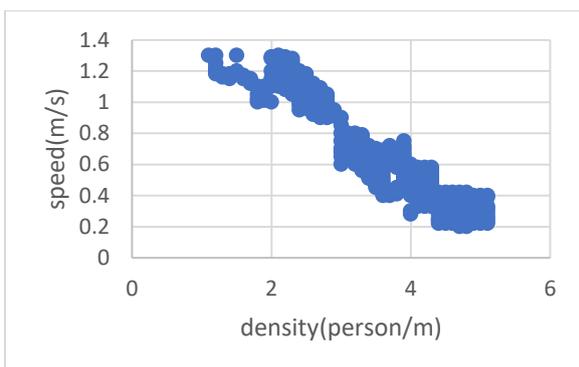


Fig 7: Speed-density graph for all female condition

It is Observed that speed would decrease and vice versa as density rises. The graph demonstrates clearly that the relationship of speed and density is not linear in nature.

VIII. SPACE-HEADWAY-SPEED RELATIONSHIP

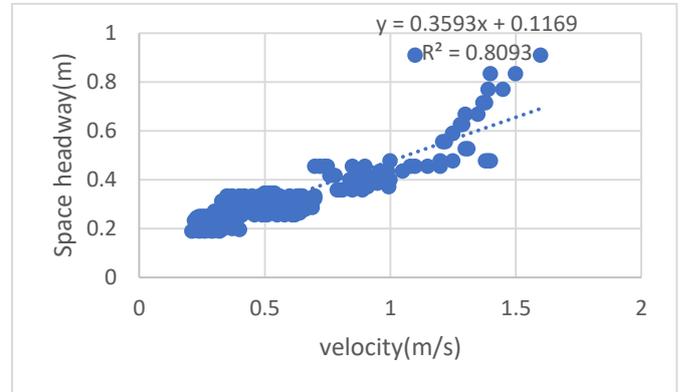


Fig 8: Space headway- speed graph for all male

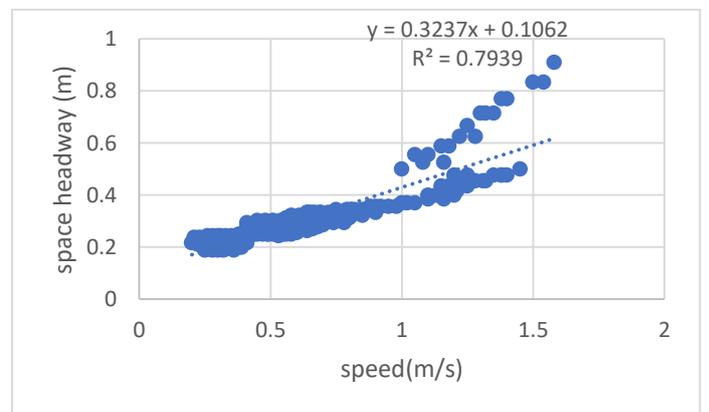


Fig 9: Space headway- speed graph for two male and one female alternatively

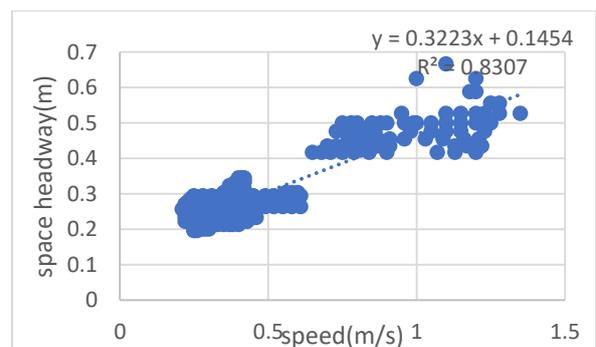


Fig 10: Space headway- speed graph for one male and one female alternatively

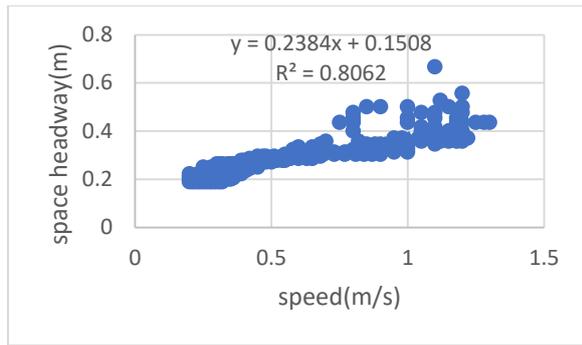


Fig 11: Space headway- speed plot for one male and two female alternatively

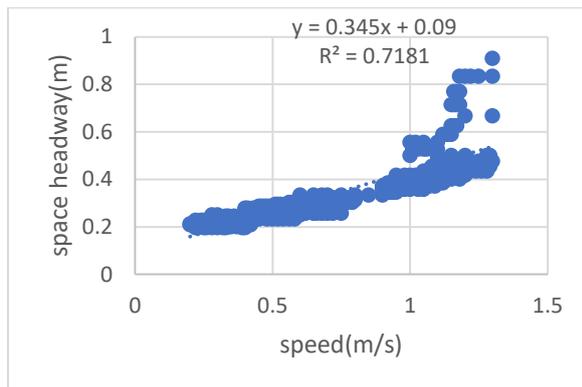


Fig 12: Space headway- speed plot for all female

IX. STUDY ON FREE FLOW SPEED

Free-flow Speed is a walking speed when pedestrians may not interact with or disturb any situations by other pedestrians. The linear progression-speed (h-v) diagram of the experiment with the corridor cannot provide the free flow rate. However, free flow intensity information was obtained by transferring one single phase in the geometric passage. The average free flow speed of male was 1,27ms⁻¹, was estimated from the above experiment. The medium is open flow speed of the female are 1.24 ms⁻¹.

X. STATSTICAL ANALYSIS BY HYPOTHEISS TESTING

A Z-test is a mathematical test in terms of which regular distribution can be approximated for distribution of the test statistics under a null hypothesis. Due to the central limit principle, certain research statistics are distributed in broad samples

Table 2: Z test value for velocity

S.No.	Combination of cases	Z calculated	Z critical	P value	Results
1	AM and AF	-4.894	1.96	<0.0001	RNH
2	AM and 2M1F	-2.730	1.96	0.006	RNH
3	AM and 1M1F	0.996	1.96	0.31	Can't RNH

roughly normally. The Z-test has a single essential value for each importance stage, making it more convenient than the T-test of student with distinct essential values for each sample scale. Many statistical analyses may also be conducted easily as rough Z tests when the sample size is broad or when the population variance is established. The statistical hypothesis evaluation has been completed analysis.

Hypothesis test:

$$z = \frac{\bar{x}_1 - \bar{x}_2 - \Delta}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Where,

x = Standardized random variable

x̄ = Mean of the data

σ = Population standard deviation.

Null hypothesis: H 0: μ 1 = μ 2

Or H 0: μ 1 - μ 2 = 0

Alternative hypothesis: Ha: μ 1 ≠ μ 2

Now to check hypothesis we have performed Z value test

Table 1: Study on intercept (a) and slope (b) of the fundamental

S.No	Cases	Intercept	Slope	R2
1	AM	0.1169	0.3539	0.8093
2	2M1F	0.1062	0.3237	0.7939
3	1M1F	0.1454	0.3223	0.8307
4	1M2F	0.1508	0.2384	0.8062
5	AF	0.09	0.345	0.7181

4	AM and 1M2F	1.404	1.96	0.16	Can't RNH
5	1M1F and 1M2F	0.3706	1.96	0.71	Can't RNH
6	1M1F and AF	-6.172	1.96	<0.0001	RNH
7	2M1F and 1M1F	3.816	1.96	<0.001	RNH
8	2M1F and 1M2F	4.340	1.96	<0.0001	RNH
9	2M1F and AF	-1.711	1.96	0.08	Can't RNH

Here alpha is 5% (0.05) and the level of confidence is 95%. If alpha is more than p-value than the null hypothesis is rejected and the alternate hypothesis is accepted.

Table 3: Z test value for space headway

S.No.	Combination of cases	Z calculated	Z critical	P value	Results
1	AM and AF	0.873	1.96	0.03	RNH
2	AM and 2M1F	0.209	1.96	0.83	Can't RNH
3	AM and 1M1F	-0.583	1.96	0.55	Can't RNH
4	AM and 1M2F	4.585	1.96	<0.0001	RNH
5	1M1F and 1M2F	5.510	1.96	<0.001	RNH
6	1M1F and AF	-0.265	1.96	0.79	Can't RNH
7	2M1F and 1M1F	-0.754	1.96	0.45	Can't RNH
8	2M1F and 1M2F	4.387	1.96	<0.0001	RNH
9	2M1F and AF	-1.055	1.96	0.29	Can't RNH

Table 4: Final Results

S.No.	Data combination	Velocity	Result	Space headway	Result	Final Result
1	AM and AF	RNH	Gender impact exist	RNH	Gender impact exist	Gender impact exist
2	AM and 2M1F	RNH	Gender impact exist	Can't RNH	Gender impact does not exist	Gender impact exist
3	AM and 1M1F	Can't RNH	Gender impact does not exist	Can't RNH	Gender impact does not exist	Gender impact does not exist
4	AM and 1M2F	Can't RNH	Gender impact does not exist	RNH	Gender impact exist	Gender impact exist
5	1M1F and 1M2F	Can't RNH	Gender impact does not exist	RNH	Gender impact exist	Gender impact exist
6	1M1F and AF	RNH	Gender impact exist	Can't RNH	Gender impact does not exist	Gender impact exist
7	2M1F and 1M1F	RNH	Gender impact exist	Can't RNH	Gender impact does not exist	Gender impact exist
8	2M1F and 1M2F	RNH	Gender impact exist	RNH	Gender impact exist	Gender impact exist
9	2M1F and AF	Can't RNH	Gender impact does not exist	Can't RNH	Gender impact does not exist	Gender impact does not exist

From the above test, it is seen that the impact of gender and gender mix condition on the pedestrian flow diagram is there. So, there are many different cases of gender and gender mix and in this case, we have clearly seen the z test value of each different cases and all the z test values of each different cases are different from each other. Basically, Z test follow normal distribution curve. Now we have different

value of Z so we can check whether the value of Z lies in the acceptance portion of the graph or outside the acceptance of the graph. From that if the value of Z lies outside of the acceptance of graph than null hypothesis would be rejected and this is also checked by the P value. If the P value is less than 5% than null hypothesis will be rejected. And If null hypothesis is rejected that means we have to go for alternative

hypothesis and it also means that gender mix condition effect the pedestrian fundamental diagram.

The Z trial result, the impact of speed was noticed in five cases and these cases are: -

1. All male & All female
2. All male & Two male and one female
3. One male one female & All female
4. Two male one female & one male two female
5. Two male & one male one female

After doing Z test, we have seen the impact of gender and gender mix condition in following four cases.

1. All male & All female
2. All male & one male and two female
3. One male one female & one male two female
4. Two male one female & one male two female

Now we talk about the both the condition that means for velocity and space headway simultaneously than a greater number of the cases shows that the gender mix condition doses impact the walking pattern of pedestrians except these two cases and these two cases are: -

1. All male & one male one female
2. Two male one female & All female

XI. CONCLUSION

The aim of this research was to show the impacts of the gender influence on pedestrian fundamental diagram using different hypothesis. The findings were correlated statistically by Z-test and are compared with other studies in the field of pedestrian motion with a single file pedestrian step. So, this study shows that the gender mix condition doses impact the walking pattern of pedestrian whether it is related to velocity or it is related space and it is also observed that women are more superior to their private space as compared to man. When the gender mix condition occurs then automatically pedestrians feels some restriction towards their walking so they reduce their speed of walking and more concern about their private space and try to maintain the space with other individual and man are less concerned about their personal space. This study clearly shows that the when the gender mix condition takes place in crowd than this impacts the walking pattern of pedestrian. And also found out that, the impact of gender mix condition on pedestrian walking pattern is also dependent on geometric feature of corridor.

This study helps to design the corridor of a football stadium, cricket stadium, Movie theaters and many more public gathering places.

XII. FUTURE SCOPE

This study can be carried out for different age group and to check whether it will impact the walking pattern or not.

The same analysis can also be done for different geometric feature of corridor and then check it will impact the results or not.

This study can also be carried out for different district in same state and check their walking pattern.

This study can also be performed for same geometry but in night or can also carried out for different weather conditions.

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