A Review of Pedestrian Fundamental & Geometric Characteristics

[1]Anu Arora, [2]Minakshi

[1]M. Tech Scholar, [2]Assistant Professor
Civil Engineering Department
Transportation Engineering
CBS Group of Institutions

***Abstract*: It is necessary to do research on pedestrian movement in order to better design places for human circulation, such as airports, shopping malls, subways, fairs, and sidewalks, for example. The scientific method may be used to study pedestrian mobility on a variety of levels. At the microscopic level, it is possible to investigate the flow parameters (such as speed and density) of pedestrian motion. At the microscopic level, it is feasible to track the paths followed by various pedestrians while they are on the move. According to the findings of this study, individuals are travelling through a location at various densities as they are arranging their routes, and they are doing so in a flow space while doing so. On a mesoscopic scale, the flow properties vary depending on the location and time of the flow. It is the purpose of this thesis to investigate the topic of pedestrian study on a micrometre scale. The pedestrian flow and geometric features of pedestrian facilities are studied. In this review pedestrians with a foundation of knowledge and an adaptation in order for them to understand how these facilities influence their motion explored.**

***Keywords*: Pedestrian Fundamental, Cultural and Gender, Geometric Characteristics**

I. INTRODUCTION

A number of nations have tried to boost pedestrian activity in order to have more people walking, which has the effect of lessening traffic congestion and air pollution. And on top of that, walking is useful in linking various transportation methods. The location is also less polluted than it was, and thus, method of connecting with, as well as being the only way to travel between locations when other modes of transportation are unavailable. Study of pedestrian flow characteristics, including, free flow, is critical in order to provide an integrated approach to traffic planning in metropolitan settings. individual pedestrians' behaviour was analysed in more detail by academics and a study was commissioned that addressed pedestrian flow in an urban setting (see Section 3). It is crucial investigate mobility, taking into consideration both the mindset and cognitive abilities of pedestrians, and including the interplay surroundings. Pedestrians make complex decisions, including observing their environment, determining their strategy, and adapting their plan as required. Understanding human behaviour is a difficult task. The reaction is not straightforward like a mechanical one. Human conduct is profoundly influenced by human characteristics. For a different viewpoint, let's consider vehicle flow which is confined by traffic regulations and located in defined corridors. On the other hand, pedestrian movement tends to be considerably more random. No two pedestrians' activities are exactly same during the journey. The behaviour of the group of pedestrians is very different from that of each individual pedestrian.

Examining pedestrian behaviour at various locations includes: walking speed (Kretz., 2008); Zhuang & Wu, 2011), These research findings are specific to walkways, crosswalks, staircases, and terminals. They will also examine the flow and density of the pedestrians' unrestricted movement. Overall, all their pedestrian flow characteristics research is directed at studying many factors on a local scale, the the population. useful determining what sort amenities are needed in a certain location, and are helpful in devising such facilities. Additionally, Pedestrian Flow characteristics studies look at how fast people move, taking into consideration factors such as gender, age, abilities, and other variables. This enables researchers to delve more deeply into the pedestrians' behaviours. This research may be expanded to assess the pedestrian LOS of the facilities in question.

Fundamental diagrams of various flow types

- Traffic density is correlated with vehicle velocity: As the number of cars on a route increases, vehicle velocity will slow down.
- The rate of traffic flow in the control zone cannot increase or decrease in order to avoid congestion.
- In order for flow to shift from stable to unstable, there must be a critical

For use in traffic flow visualisation, the main tool is the basic diagram. Three distinct diagrams compose fundamentals of fundamental diagrams. Two-dimensional graphs are graphs. The equation that describes traffic flow is flow = speed * density; all the graphs are linked together via this equation. The basic graphics were created using data points from the field and fitting these points to a curve. Researchers may now investigate the connection between the using basic diagrams.

Speed-density

As the density of the highway rises, the speed drops. When the speed axis (the x-axis) is crossed y-axis), the lies on (the -axis). Here approaches zero, and the higher the slower the vehicle speeds on the road. matches speed is zero.

Flow-density

Traffic flow theory involves the use of flow-density diagrams to represent traffic movement on the road. Flow density graphs are now split into two general classes: better depicts real-world occurrences in academia. Two vectors comprise the triangle curve. The

first vector represents the part of the curve that has no restriction in terms of fluid flow. The free flow velocity vector of a highway is used to generate this vector. This is the second vector. It is formed by zeroing the flow and jam density in the. Even if there are more vehicles on the road, the number of cars passing a single location is less than if there were fewer cars on the road. The intersection of free flow and congested vectors is regarded the capacity of the highway; the greatest number of cars that may location particular is traffic situation free flow is most congested. At this moment, the flow and density are both at their optimal levels. Flow density diagrams are often used to provide an indication of traffic volume on a highway. While traffic flow circumstances restrict the options for creating time-space diagrams, a time-space diagram may be used to provide section.

Speed-flow

The rate at which the optimal flow occurs is assessed using flow diagrams. Currently, there are two different kinds of speed-flow curves in existence. In addition to the free flow and congested flow curves, the includes the flow. may distinct, which means. In example of the, flow happens distinct when and greater, flow occurs at a lower density and a slower speed when the density is higher and the speed is lower. A free-flowing highway -flowing optimal achieved. form of the congested branch changes to a parabolic shape after the optimal flow has been achieved. This is a parabola, the second speed flow diagram. The parabola implies that only when the density is zero can there exist free flow speed. Also, as flow rises, the speed diminishes. Also included in this parabolic graph is an optimal flow. In order to maintain optimal flow, the parabolic flow chart will separate the free flow and crowded branches.

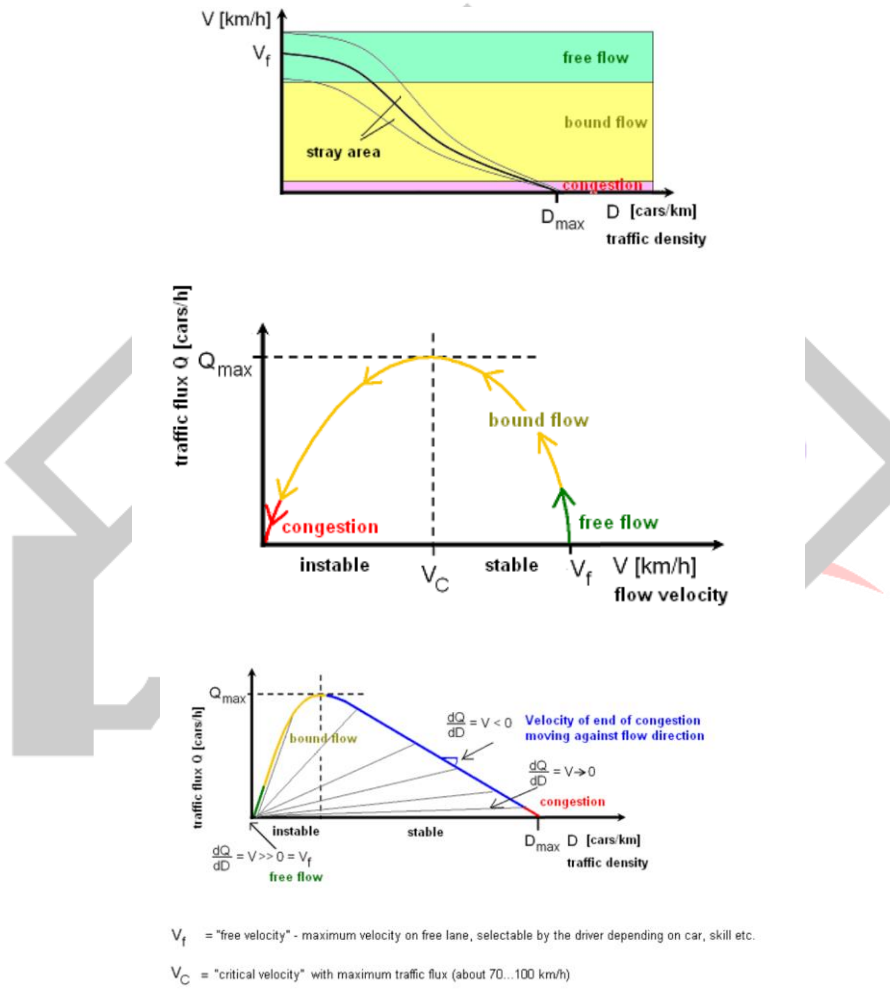

Fig. 1: Fundamental diagrams of various flow types

II. LITERATURE REVIEW

Pan, H., Zhang, J., Song, W., & Yao, B. (2021), Better pedestrian evacuation with more accessible wheelchairs has significant implications for public safety. Pedestrian trials are conducted in corridors for those who utilise an assistive device. In comparing able-bodied pedestrians with wheelchair users, it was shown that able-bodied pedestrians had a 38.9% increase in their unhindered speed and a 24.5% decrease in their total relaxation time. Although wheelchair users' forward proxemic values are lower, their reverse values are greater. While individuals with disabilities are bigger than able-bodied participants, able-bodied participants are larger than dwarf ones. Although wheelchair users may be present, the pedestrian flow density range (0.59 to 4.17 m−2) and flow rate (1.49 ± 0.21 m s−1) decrease because of this. 11.76% and 20.93% longer, respectively, are the critical headway and safe reaction time. The study's results reveal reduced efficiency and increased safety requirements for pedestrian movement, especially for people in wheelchairs, which is relevant for construction simulation, facility design, and guiding during a building evacuation.

Ahmed, A., Ngoduy, D., Adnan, M., & Baig, M. A. U. (2021), Heterogeneous traffic streams, on the other hand, behave differently from ordinary traffic streams. Many of the traffic flow models that already exist are designed around a certain traffic stream that follows tight lane discipline. Although traffic tends to be very heterogeneous in South Asian nations, little or no lane discipline is seen.

This is the first time that traffic flow diagrams have been developed from scratch by analysing UAV-captured traffic footage in Karachi, Pakistan. FDs are designed to represent the full spectrum of speed-density data. 85th percentile speeds to set speed restrictions on major urban arterials are estimated using stochastic FDs. The multi-modal FDs exhibit a clear distinction in the traffic stream between various modes. Aggressive motorcycle riders who are at an increased risk of accidents demonstrate the necessity for rules that govern traffic flow.

This study's most important addition is the use of a UAV-based geospatial analytic method to extract precise longitudinal and lateral distances between cars, which may be used to analyse traffic flow macroscopic and microscopic characteristics. In this research, gaps between cars were shown to be directly proportional to traffic density. One might infer that the long-term differences between the gaps observed for locally diverse traffic and those predicted by a conventional car-following model were substantial. Both the macroscopic and microscopic models described in this research may be used to design new traffic flow models, as well as calibrate current models for the traffic streams with comparable heterogeneity and lane behaviour.

Shi, D., Ma, J., Luo, Q., Li, X., Chen, J., & Lin, P. (2021), Passengers with baggage often travel in transit terminals, which also hinders their movement as well as those who go without bags, particularly on stairs. Congestion may be more severe during peak hours as a consequence. However, no comprehensive research has been done on the effect of baggage on the walking movement characteristics of pedestrians as they climb and descend stairs. In this case, in order to test whether single-file luggage-laden travel reduces environmental impact, a series of single-file luggage-laden movement tests were done in a controlled environment. Trajectories have been created to study how baggage ratios influence movement characteristics. The space-time graphic reveals that when the baggage percentage rises, the average stopping time progressively increases. Two distinct regimes are present when it comes to headway and speed: one where the rules are not restricting, and the other where they are very restricting. Descending headway and tread depth are equal, whereas ascending headway is larger. In the situation with a high luggage-laden ratio, the pedestrian adaption time is greater than that of zero. Also, when speed increases, pedestrian lateral sway amplitude declines at a quicker pace during the descent than the ascent. The findings from this research may assist in the design of future pedestrian facilities as well as the calibration and verification of pedestrian models, due to the link between carrying baggage and how it affects how many steps one climbs and how many steps one descends.

Fu, Z., Li, T., Deng, Q., Schadschneider, A., Luo, L., & Ma, J. (2021), Previous research has revealed that various research projects find drastically varied pedestrian flow characteristics. So yet, no one knows exactly where these inconsistencies originate. We use controlled studies to investigate the potential impact of geometry on pedestrian traffic. In order to find out whether curvature influences flow characteristics, we must conduct a comparison of flows and densities for oval and circular set-ups. When flow reaches the highest percentage in the straight passages (curvature K=0), flow in the curved passages is about 20% higher. We may think of this decrease in flow in the curved section as an example of spatial pedestrian distribution. When investigating the effect of curvature on pedestrian distribution, the results show that curvature promotes a more uniform distribution of pedestrians than does the straight portion. The greater homogeneity on the straight section enables more effective use of available space, resulting in higher overall flows.

Ma, J., Shi, D., & Li, T. (2020), Pedestrian dynamics have been popular subjects of study over the last several decades, as a result of the rise in the number and frequency of significant events. Due to the various environmental conditions, the stride of escaping people differs from that of non-escaping people. Fundamental diagrams for single-file pedestrian movement have been the focus of an experimental research described in the current article. Each scenario had a range of possible heights: 1.0, 1.2, 1.4, 1.6, and 2.0 metres. Flow and flow rate were studied in the connection to velocity. Velocity and density, density and flow, and flow rate and spatial headway were examined. When the walker's free walking speed is measured at 2 m, the pedestrian may go the farthest. The speed of pedestrians breaks down into two categories, depending on the density of the scenario. 0.5 m/s (when walking at a density of 2.0 and 1.6 m) and 0.25 m/s (when walking at a density of 1.0, 1.2, and 1.4 m). This picture, often known as the "basic diagram," consists of three segments, including the laminar flow condition, the stop and go phenomena, and the jammed state. This study is useful in comprehending the effects of varying pedestrian evacuation heights.

Duives, D. C., Sparnaaij, M., & Hoogendoorn, S. P. (2020), Workstations using the capacity of pedestrian infrastructures have generally been concerned with typical movement instances in unidirectional settings, and have concentrated on moderate-density scenarios. In these workstations, users are asked to act "normally." On the other hand, at major events and at railway stations, higher-density pedestrian flows are more common, and the flow conditions are more complex. Pedestrians do not necessarily act "normally" in this context. The purpose of this research is to discover the overall and local dynamics of the crowd due to differences in walking pace and the flow of people. CrowdLimits, a large-scale pedestrian experiment, was done by Delft University of Technology to address the question, "How many pedestrians can a road support?" The early study of the participants' movements shows that, although the different walking speeds and distribution among flows affect the overall form of the basic diagram, the inclusion of significant variations in walking speed and flow distribution serve to make this clearer.

Aghamohammadi, R., & Laval, J. A. (2020), Real-time implementation of big city encounter calculation, may be the main issue. As shown in 2008, a discrete-space DTA model was created based on the empirical data which proved the presence . Both parallel and directly, several DTA models that are developed using conservation principles in a two-dimensional space. While there is general agreement that a provide a to, currently known if methods compatible. This article attempts to provide more knowledge on this topic by summarising the existing studies on the different modelling methods. stalled-traffic problems, which cause unrealistic gridlock, while are exceptions. inconsistent and neglect network effects, particularly intersections. Finally, current models cannot handle large-scale networks. Additionally, further investigation is required to incorporate departure time choice, improve existing

numerical methods, and research the properties of system optimum solutions. Additionally, a review is required to see how real-time applicability compares to traditional DTA methods.

Kumar, K., & Singh, S. K., Possible techniques to pedestrian movement research include data collecting methods including field research, experimental observation, and controlled testing, as well as developing pedestrian models. Most of these many types of research are susceptible to building basic visualisations. In order to see how various circumstances affect the basic diagram, the easiest approach is to follow the movement of pedestrians along a line of the condor. We must look at various aspect and unique impacts on pedestrian movement, such as spaces for human circulation, to provide improved pedestrian facilities and designs for human mobility. With this thesis, it is hoped to determine how pedestrian density affects the gender mix situation on a basic level. Via basic diagram, whether gender and gender mix affect pedestrian behaviour or not is examined in the is contribution. The simplest experimental setup, known as the single-file movement of people moving down a line under closed boundary conditions, is used for the experiment. The Mean free flow speed for male pedestrians is 1.27ms−1 whereas that for female pedestrians is determined to be 1.24ms−1. It is well knowledge that when women are walking, they are more aware of their personal space than men. This may be because their self-organizing activity is such a contrast. Without any statistical evidence, it is impossible to know whether or not there exist contrasts. By using a statistical hypothesis test, it is shown that these differences do really exist, and thus the gender and gender mix influence in the basic diagram should be taken into consideration.

Subaih, R., Maree, M., Chraibi, M., Awad, S., & Zanoon, T. (2019), A number of experiments have been done in recent years to see how pedestrians differ from one another depending on various variables including culture and motivation. However, when it comes to the effect of gender on a crowd, less emphasis has been paid. The purpose of this experiment is to look at the changes in pedestrian dynamics on staircases that have restricted boundaries. As far as the primary benefit is concerned, this simpler set-up has the advantage of providing simple control over the density, which means we can do tests on the Fundamental Diagram (density-velocity relationship, FD) with consistent and predictable results. This article focuses on the principal features of pedestrian motion found in tests done in Palestine, which use a single-file flow of pedestrian data. Finally, we carry out a comparative analysis of gender-based FDs across the world, in order to investigate their dynamics and motion flows.

Wang, L., & Shen, S. (2019), Because of its importance in public transit, pedestrian dynamics has a wide range of applications, including evacuation routes and design and optimization of pedestrian facilities. the basic Fig illustrates the connection between pedestrian density, velocity, and pedestrian flow To adjust for various environments, a foundational diagram changes for hallways, stairways, and ramps, and it also relies on whether the pedestrian movement is one-way or two-way. However, it is unclear whether or not there is a generic model for the basic diagram. To describe the connection between walking speed and density, we utilise a decay model. Previously, it was believed that maximum density was the density where pedestrians don't move; however, that notion is now known as density in which “turbulent” crowd circumstances occur. The pedestrian movement degradation feature is present, which is seldom researched previously. According to the decay model, empirical data agrees well, and thus explains the various basic diagrams' discrepancy.

Migon Favaretto, R., Rosa dos Santos, R., Raupp Musse, S., Vilanova, F., & Brandelli Costa, A. (2019), This article introduces a research that explores group behaviour in a controlled experiment centred on variable personal spaces, focusing on a notable trait that varies across cultures. To begin, we want to research and evaluate how various groups define and use their personal space. Our second aim is to simulate virtual agents and utilise their simulated motions to simulate comparable real-world circumstances and test the validity of those movements using actual videos. The primary aim of our project is to be able to retrieve information from videos and then apply it to population dynamics. We also use the OCEAN model to analyse the videos' personalities (Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism). Lastly, we provide a simulation approach to duplicate the basic diagram experiment conducted in different nations based on the OCEAN psychological trait model as input. According to the findings, the simulated nations exhibit the same consistent features with literature that has already been predicted.

Favaretto, R. M., Musse, S. R., & Costa, A. B. (2019), Three country-specific basic graphical tests on personal distance and walking speeds were conducted over the course of this chapter. Since each movie only had one group that completed the same task, we only evaluated the participants in the videos. IV-HCD (Cultural) was therefore removed as a consequence. Additionally, we use prior research as a guide for assessing our trial results to make sure that our findings are consistent with those published in the paper by Sorokowska et al. (J Cross-Cultural Psychol 48:577–592, 2017). The technique described in Section 9.1 was utilised in the experiment. Section 9.2 is charged with doing a complete investigation and analysis of some of the FD findings. In Section 9.3, Sorokowska et al. (J Cross-Cultural Psychol 48:577–592, 2017) provide a study on personal space, as discovered by the researchers who authored the article. The section on personality and emotion that is part of the core diagram's personality and emotion sections describes how such qualities appear in the basic diagram.

Alonso, B., Ibeas, Á., Musolino, G., Rindone, C., & Vitetta, A. (2019), Network Macroscopic Fundamental Diagram (NMFD). Traffic control and management has already been done, and now traffic sensors may be used. The relationship between traffic management measures and levels of traffic congestion is unclear. NMFDs found in experiments are useful for trying to understand this relationship.

It is included in two parts of the book. This model provides a technique for identifying design problems around signal planning at junctions, and it incorporates NMF variables. This part looks at the relationships between observed NMFDs and traffic management techniques that were based on real traffic data. traffic data, variables, functions, and graphs are found and monitored at the link and network levels (NMFD). Two neighbouring city centres in Santander utilise the method of unifying two separate areas to make them seem as one (Spain). These zones were identified using traffic characteristics and land use. Road users utilise these sub-networks regardless of their regulatory authority (with the same behavioural strategy). Traffic data (flows, densities) have been collected and monitored through loop sensors, and traffic signal control plans have been connected with this data.

According to these results, link and network traffic flow characteristics are influenced by junction regulation. Two homogenous neighbouring zones exhibited statistically significant differences in NMFDs. This study's results must be repeated in other realistic transportation systems before they can be considered reliable.

Bosina, E., & Weidmann, U. (2018), There is a wide variation in how fast a pedestrian walk under different conditions. The pedestrian basic diagram serves as a visual representation of people's mobility. An efficient and practical design relies on accurate numbers for a pedestrian facility that use the basic schematic. That so, no method has yet been discovered to get a fundamental diagram that does not require similar measurement circumstances. The paradigm described in this article may be applied to all pedestrians. This model represents a better picture of human mobility since it is based on data from scholarly studies which explore different components of pedestrian movement and how they connect to one another when walking. We may analyse the overall diagram in relation to the surroundings utilising pedestrian characteristics. To produce fundamental diagrams particularly suited to a given situation, a basic diagram model may be used first. This creates the ability to construct pedestrian facilities to fit the circumstance.

Hoogendoorn, S. P., Daamen, W., Knoop, V. L., Steenbakkers, J., & Sarvi, M. (2018), network and basic macroscopic diagrams have received renewed attention during the past decade (MFD). Today, the concept of the MFD continues to be useful whether considered theoretically or in relation to vehicle network dynamics.

We focus on the pedestrian macroscopic basic diagram's existence and characteristics (p-MFD). The objective of our research is to learn how we may infer the p-MFD given likely fundamental local diagrams (FDs). As we show, the flow of pedestrians exiting a pedestrian network is equal to the flow of pedestrians entering the network, as long as the density of the network is constant and the change in network density is taken into account. It is important to account for network traffic in order to provide an accurate representation of overall network conditions. Simple connections between density and speed can be solved using the Greenshields and Underwood fundamental diagrams, while a more complex relationship is studied using Weidmann and Newell's triangular FD. The p-MFD is shown in the article how the procedure described in the article may be developed via microsimulation or by experimentation on pedestrian activity. The results confirm the theoretical predictions, which implies that the p-MFD theory is accurate. Hysteresis, which may be observed in vehicle network dynamics, is also discussed.

Finally, we've provided you with some concrete, real-world examples of the concepts we've discussed here.

Cao, S., Lian, L., Chen, M., Yao, M., Song, W., & Fang, Z. (2018), The question of basic schematic differences in pedestrian movement is studied in this article. Previous research suggests using a new measuring technique, which uses the going back as a negative contribution to pedestrian flow. To begin, several measuring techniques are compared, and then it is seen that minor discrepancies exist in the underlying basic schematics of the same experiment. In order to deal with differences in measurements that may have an impact on the final findings, we compare the basic diagrams of Chinese and German experiments by utilising the same measurement techniques and the fundamental diagrams of the two sets of experiments turn out to be remarkably different. For the study of experimental video, it was found that participants in two trials show various levels of motivation and competitiveness, which influences the significant disparity in diagrams. We should also examine two German trials that had the same number of participants with an average age of 23: the Hermes experiment and the BaSiGo experiment. Free velocity is used to assess the level of motivation and motivation disparity between trials causes the huge gap in basic diagrams. This research may help people comprehend the global and microscopic effects of pedestrian activity.

Vanumu, L. D., Rao, K. R., & Tiwari, G. (2017), Once traffic speeds and density have been defined, a more efficient simulation may be used to simulate pedestrian movement. Speed, flow, and density are the primary modelling elements when it comes to flow models. The study's goal is to assess the basic pedestrian flow diagrams and geometric components' conception. Flow parameters and pedestrian walking speeds are also discussed in this study. They conducted a comprehensive study of pedestrian flow characteristics based on methods such as field, experimental, and simulation in order to meet the objective of this work. After a comprehensive literature analysis, this article highlights several research gaps that open the way for new pedestrian flow knowledge.

Chen, J., Lo, S. M., & Ma, J. (2017)., The walking speeds of pedestrians descending and climbing stairs in medium-to-dense groups may vary based on the individual pedestrians in the crowd. This experiment was conducted to simulate pedestrian movements in a variety of circumstances to create a wide range of densities. the patterns across a broad pedestrian density range for staircase movement are represented in the basic diagram Additional details on pedestrian speed and density, headway, and lateral sway are given in the following sections. The speed reduction rate seems to vary depending on the amount of pedestrian density. In contrast, a reduction in headway is causing two movement speeds: free movement and restricted movement. By measuring the number of steps separating pedestrians in longitudinal direction, we have shown that pedestrian speed may be characterised. Pedestrian modelling may benefit from these additions, and the assessment of the evacuation of a staircase can be improved as a result.

Bosina, E., & Weidmann, U. (2017), The basic diagram, which is also extensively used in pedestrian transit, is utilised for vehicle traffic as well. Different equations have been presented, some of which provide significantly different results. The researchers have discovered many factors influencing the pedestrian basic diagram thus far. Nevertheless, these criteria fail to account for the wide variety of diagrams presented.

There is no standard, agreed-upon definitions of the basic diagram for pedestrians, thus a review of the literature uncovers that even while the idea is in broad use, no specific description is available. There are a number of distinct flows–density and speed–density relations that are utilised as “fundamental diagrams.” The resultant basic diagram curves vary greatly depending on measurement and data assessment techniques since they are lacking a clear definition.

This work attempts to provide a pedestrian basic diagram definition. This section starts by giving a general background on the concept and then discusses where and how it may be used. The suggested definition for the pedestrian basic diagram is based on these essential ideas. The basic diagram idea has stochastic aspects to it. The basic diagram may be represented using either the mean value or using a probabilistic method. This work describes the addition of stochastic behaviour to the basic diagram.

Cao, S., Seyfried, A., Zhang, J., Holl, S., & Song, W. (2017), Unidirectional, bi-directional, and multidirectional flow diagrams are studied through experiments that are performed in a laboratory setting. Because of the density of people, pedestrians must detour or even go in a different direction because of obstructions. Because of these unintentional motions, the performance of crossings is greatly overestimated. By use of sophisticated techniques, the impacts of the basic diagrams are taken into consideration in order to assess their capabilities. compared to conventional approaches, substantial distinctions exist when it comes to capabilities. Data from, as well as from, are used to compare the basic diagrams.

Wang, J., Boltes, M., Seyfried, A., Tordeux, A., Zhang, J., Ziemer, V., & Weng, W. (2017), A varied crowd structure may be seen in various public locations or public events. More care and attention is required at facilities where a significant percentage of the people are youngsters, the elderly, or women, who are known as vulnerable groups. Designing facilities and planning for emergency evacuation need a basic understanding of the fundamental anatomy and gait characteristics of pedestrians. Investigating the impact of gender on the basic diagram and gait characteristics is a critical first step in improving the design of our facilities and reducing the likelihood of injury in public spaces. Some findings obtained in trials with single-file movements, which include boys and girls, are reported in this article. The analysis looks at the gender-specific impacts on the fundamental diagram and gait characteristic parameters such as free-flow speed, stop space (the minimal required distance between the person preceding you and you yourself), and free-flow space (the minimal required distance to walk at free-flow speed). Even though the differences between men and females are modest, it's discovered that males have substantially bigger stop space and smaller free-flow space. Also, a comparison is made between male and female gait characteristics.

Huo, F., Song, W., Chen, L., Liu, C., & Liew, K. M. (2016), the development of congestion and even the safety of evacuees is affected by stairway descent from high-rise buildings This article describes two separate experimental scenarios for stair evacuation: one where the stairs are emptied gradually, and the other where they are emptied all at once. While recording footage of the evacuation operations, the movement characteristics were also obtained. Scenario one and two studied the space–time distribution of participants moving from floor to floor, as well as how they moved between various stair landings. Next, two alternative evacuation scenarios with differing numbers of people were shown. After that, the basic schematics for pedestrians in both situations were revealed, as well as an investigation of the effects of merging flow on pedestrian movement. It has been discovered that in experimental scenario one, large time gaps between participants arise because of people with sluggish mobility who create bottlenecks. It's discovered in the experimental scenario two that those at the front of the line speed up before to merging with those who are approaching from above. Furthermore, from the analysis of the fundamental diagram, we discover that the merging flow influences the movement of pedestrians as they descend stairs, and therefore it is important to account for both the functions of the SFPE Handbook and the details of the evacuation procedures when using this guidebook to calculate the variables related to evacuation. Additionally, it has been observed that the entrance of players from adjacent levels during the merging time period results in slower speeds for upstairs participants.

Das, J. B., Chattaraj, U., & Nayak, S. (2016), The most fundamental movement is walking. Many empirical research and experiments have been performed previously to better understand pedestrian dynamics. Pedestrians are especially vulnerable road users, and prediction of their movements is very useful in many situations. Pedestrians are vary depending on the circumstance. To gather data for both field and experimental research, gender-mixed pedestrian situations are taken into consideration. In the first phase, we performed the study and also carried out associated research activities, such as gathering field data and drawing diagrams based on that data. Under ideal circumstances, there was no interference, such side-by-side pedestrian movement, or overtaking, in the experiment that measured pedestrian velocity. A simple single stream pedestrian flow, as well as a boundary condition, was tested using a very basic experimental setup. Field observations were used to analyse the fundamental diagrams of speed-density, speed-flow, flow-density, and distance headway-speed. Through hypothesis testing, differences in pedestrian flow are investigated between field observation and experimental observation.

Fang, J., Qin, Z., Hu, H., Xu, Z., & Li, H. (2012), This class of models takes much longer to get started since it simulates traffic using a traditional cellular automata algorithm. to our knowledge, slow-to-start pedestrian dynamics has not been taken into consideration in modelling. We use modelling to compare pedestrian and vehicle behaviour, and to propose a novel lattice gas (LG) model dubbed the slow response (SR) model. To verify our SR model, we recreate and replicate Seyfried's field experiments in Jülich, and then utilise its empirical data. We will be doing comparisons between the SR variant and the regular LG model. For the SR model, we found that the simulation data (probability of response time being 3 s) fitted the empirical data (slower reaction time in real life) well. The mean velocity of the SR model has a lower RMS inaccuracy than that of the conventional LG model. Our simulated results in the ps = 0.1-0.3 region are in agreement with experimental results. The actual distribution of individual velocity corresponds better with the empirical data than does the LG model, according to the data. Additionally, we use simulation to identify stop-and-go waves and phase separation in pedestrian movement. While the conventional LG model failed to replicate the unequal distribution of interspaces, the SR model successfully demonstrated it. Seyfried's studies showed a more faithful representation of pedestrian flow patterns in terms of spatio-temporal structures than the conventional LG model.

Zhang, J., Klingsch, W., Schadschneider, A., & Seyfried, A. (2011), It is well documented those pedestrian dynamics such as self-organization, as well as many other phenomena, have all been seen in a number of simulations. However, empirical datasets for quantitative calibration, such as the basic diagram, are still lacking. In order to remedy this problem, trials are done in straight corridors and T-junctions. There are four measuring techniques developed in order to examine the impacts on the basic diagram. Although they exert only a weak effect, the results indicate that they affect ρ between 3.5 and 3.7, and technique describe basic. We can now identify the occurrence of a boundary-induced phase shift because of this improved measuring technique. When it comes to corridors of various widths, we discovered that a particular flow idea applies to flow speeds less than 3.5 m2/s. Also, we demonstrate the differences between a T-junction and a straight corridor, by illustrating these disparities using contrasting basic diagrams.

Hoogendoorn, S. P., Campanella, M. C., & Daamen, W. (2011), This article describes a notion in two-dimensional pedestrian networks known as the Network Fundamental Diagram. In order to do this, we study whether the network's average performance can be modelled as a function of network density or accumulation. We prove that this is true by examining real-world and computational experiments. In the end, the form of the diagram was affected by many variables, such as the area's shape and size, its usage, and its purpose. Also, the way in which pedestrians flow into the space has an impact on the shape of the diagram. Finally, we present various scenarios in which the diagram may be used.

Ren, X., Zhang, J., Song, W., & Cao, S. (2019), Due to ageing populations and difficulties in fulfilling the mobility demands of the elderly, many nations face pressing transportation issues. We in this research look at movement features of old people when they are moving along a straight hallway, and then compare these characteristics to those of young individuals. It's apparent from the experimental data that old people's free speeds (which are free speeds youthful subjects (which are approximately 1.4 m s−1). There are comparable trends between senior pedestrians and the basic diagram of elderly pedestrians. However, in the observed density range (≤3.0 m−2), the old people's speeds the speed two normalised basic diagrams match very well derived activity concentrations is evaluated. These findings are investigated by looking at how far apart the border locations are, how close the neighbouring locations are, and the region in which pedestrians are located. While our findings may aid the development of pedestrian modelling and design of pedestrian facilities, our results could also be used to enhance the manner in which the elderly are modelled and designed for.

Zhao, X., Xia, L., Zhang, J., & Song, W. (2020), Using pedestrian modelling for crowd management and emergency evacuation planning is an excellent idea. We present an artificial neural network model of pedestrian locomotion in this article. A ped model, referred to as Semicircular Forward Space Based Pedestrian Velocity Prediction (SFSB-submodel) and Rectangular Forward Space Based Pedestrian Velocity Prediction (RFSB-submodel), predicts two different types of traffic-related outcomes. The modelling and experimental findings for both unidirectional and bidirectional pedestrian traffic are compared for straight routes. The trajectories and the basic diagrams derived from the model match the experimentally derived trajectories and diagrams perfectly. Bidirectional flow simulation exhibits typical lane-formation processes. Additionally, in the unidirectional flow case, the mean trajectory error (MTE) and mean destination error (MDE) are determined, and these values are about 0.2 m and 0.12 m. RDE is approximately 0.15 m in bidirectional flow.

Zhang, J., Klingsch, W., Schadschneider, A., & Seyfried, A. (2012), Bidirectional pedestrian streams under laboratory circumstances were studied to discover the order, as well as the importance, of the density-speed-flow diagram. In order resultant dependency data, Voronoi technique is employed. The analysis demonstrates that the particular flow idea applies for bidirectional streams as well. While there are several densities–flow connections in the measured density range, there are no major variations in density–flow interactions across different bidirectional stream orders. Bidirectional streams with several orderings are contrasted to unidirectional streams with just one ordering. The graph depicts changes in the form of the relation when ρ increases by more than one metre per second squared. In unidirectional streams, the maximum of the particular flow is greater than that of all bidirectional streams, which were studied.

Chattaraj, U., Seyfrid, A., And Chakroborty, P. (2009), This relationship between speed and density is linked to every pedestrian dynamic self-organization event, which gives rise to the possibility of doing quantitative analyses on them. In addition to streams in corridors, however, the relationship between elementary systems, like pedestrians, is only partially understood. The comparison of data from literature reveals those measures, such as those found in textbooks, as well as the specifications in texts, are substantially different. In this article, the authors investigate the reasons of these deviations: cultural factors and corridor length. To minimise as much as possible the effects that aren't intentionally produced, the selected system has a lower degree of freedom and therefore the simplest feasible system, which is that of pedestrians moving along a straight path on a closed border. While Indian test people show less density dependence than German test persons, Indian test persons travel faster than German test persons. Surprisingly, the Indians' chaotic, unordered conduct is more successful than the Germans' disciplined, ordered behaviour. It is likely that they vary in their level of self-organization. There is no available statistical evidence on which to base any conclusions, thus one cannot tell if there are differences or not. Assumptions have been tested and shown to be true by using hypothesis tests. This finding confirms the presence of cultural variations in the basic diagram of pedestrians.

name: Anke Seyfried, co-directors, in conjunction with Meike Boltes, Manja Kähler, Norbert Klingsch, Paul Portz, Jörg Rupprecht, and others (2010), Pedestrian dynamics have recently been modelled in several ways, such as for the construction of exits. Nonetheless, so far no effort has been made to verify their accuracy. Also in the experimental data set are less than acceptable situations such as these. The basic parameter used to describe the dynamic of crowds, i.e. flow or velocity, links to the fundamental diagram, which is the density-dependence of the flow or velocity. However, measurements in various handbooks, as well as the standards listed in them, vary significantly. What is true for the bottleneck flow is also true for the flows downstream. We then provide an overview of a study effort that has had tests conducted on up to 250 people, all of whom are under carefully controlled laboratory settings. Every person's trajectory is measured in great detail to understand the big picture and find leaks in the pipeline. Measuring strategies enable to investigate how the resultant relationships are affected by the measurement method. The surprising thing was that the techniques showed a wide range of variation. These may be the reason for the unexpected discrepancy in the previously cited literature. Since the findings are critical for comparing experimental data acquired in various settings, and for the validation of models, the results are very important.

It is composed of three authors, Angela Seyfried, André Portz, and Amelia Schadschneider (2010). For crowded pedestrian traffic, a variety of experimental findings are provided. We use a technique that offers measurements on an individual scale for data analysis. These results demonstrate that moving and halting states coexist and this implies the complicated structure of pedestrian basic diagrams. Furthermore, we provide a model that closely resembles event-driven strategies. The velocity-density relation and phase separation are accurate to within two percent. A wider range of parameters suggests that pedestrian diversity is important for phase separation.

From right to left: Hoogendoorn, S. P., Campanella, M. C., and Daamen (2010), This article deals with the Macroscopic Fundamental Diagram, which details the dynamics of pedestrian networks in two dimensions. In this investigation, we want to understand whether the network's average performance may be defined as the network's density or network accumulation. By demonstrating that this is true with respect to the data from walking experiments and the microscopic pedestrian flow model, we are able to conclude that this is correct. Once it was discovered that the diagram's form was affected by a number of variables, such as shape and size of the area, usage and function, and pedestrian flow composition, it was established that the diagram's shape is influenced by a number of factors. We also show how this graphic may be used for pedestrian networks.
Seyfried, A. and Schadschneider, note (2009), Various methods for simulating pedestrian dynamics have been been forth in recent years. Nonetheless, so far, no effort has been made to verify their accuracy. The debate is no longer focused on the replication of empirically observed collective processes like lane creation, but rather on the articulation of dynamics in a novel and innovative way. While this may provide an idea of the realism of the model, accurate quantitative predictions are needed for practical applications. For calibration, we concentrate on the basic diagram that is really important. Also, we show how the cellular automaton floor field model, the original inspiration for many multi-agent simulations, may be implemented in software. This study doesn't look at anything but the basic diagram's characteristics. We also examine the impact of disputes and friction effects and how these affect evacuation timeframes.

III. CONCLUSION AND FUTURE SCOPE

Among the total number of trips made, walking makes up a substantial percentage of those travels, which requires paying more attention to pedestrian flow studies to make them an essential element of urban planning. components urban planning, studies pedestrian features include deciding required. The bulk of experimental research are performed in industrialised nations, find pedestrian that best fits (Seyfried et al., 2009). As far as emerging nations are concerned, there is little interest. Due to the fact that people in developing nations don't walk as often as those in developed countries, results from research performed relevant to in. The crowded lack of private amenities greatly influences pedestrian behaviour. In addition, cultural factors explain disparities in outcomes according to Fruin (1971) and Helbing et al (2007). Crowded and emerging nations require more research. Included in the review article are many noteworthy research on pedestrian flow features that could not be discussed in more detail because of space limitations. To many researchers, phenomena, as a consequence of which various researchers have performed their investigations at varied places. In order to complete the many current research, on different conditions, varied amenities metropolitan areas, a comprehensive literature analysis is performed. This study aims to discover certain features of pedestrian movement that are extremely important when it comes to developing pedestrian simulation models. connections are these qualities. The aim of this study is to highlight the problem of remedy lacking these that may be facing. Pedestrian conduct during complete trips in urban environments was addressed in the research.

References

[1] Pan, H., Zhang, J., Song, W., & Yao, B. (2021). Fundamental diagram of pedestrian flow including wheelchair users in straight corridors. *Journal of Statistical Mechanics: Theory and Experiment*, *2021*(3), 033411.
[2] Ahmed, A., Ngoduy, D., Adnan, M., & Baig, M. A. U. (2021). On the fundamental diagram and driving behavior modeling of heterogeneous traffic flow using UAV-based data. *Transportation Research Part A: Policy and Practice*, *148*, 100-115.
[3] Shi, D., Ma, J., Luo, Q., Li, X., Chen, J., & Lin, P. (2021). Fundamental diagrams of luggage-laden pedestrians ascending and descending stairs. *Physica A: Statistical Mechanics and its Applications*, *572*, 125880.
[4] Fu, Z., Li, T., Deng, Q., Schadschneider, A., Luo, L., & Ma, J. (2021). Effect of turning curvature on the single-file dynamics of pedestrian flow: An experimental study. *Physica A: Statistical Mechanics and its Applications*, *563*, 125405.
[5] Ma, J., Shi, D., & Li, T. (2020). Pedestrian Fundamental Diagram in Between Normal Walk and Crawling. In *Traffic and Granular Flow 2019* (pp. 185-194). Springer, Cham.
[6] Duives, D. C., Sparnaaij, M., & Hoogendoorn, S. P. (2020). The Impact of Walking Speed Heterogeneity on the Pedestrian Fundamental Diagram. In *Traffic and Granular Flow 2019* (pp. 53-59). Springer, Cham.
[7] Aghamohammadi, R., & Laval, J. A. (2020). Dynamic traffic assignment using the macroscopic fundamental diagram: A review of vehicular and pedestrian flow models. *Transportation Research Part B: Methodological*, *137*, 99-118.
[8] Kumar, K., & Singh, S. K. Impacts of Gender and Gender Mix on Pedestrian Fundamental Diagram.
[9] Subaih, R., Maree, M., Chraibi, M., Awad, S., & Zanoon, T. (2019, September). Gender-based insights into the fundamental diagram of pedestrian dynamics. In *International Conference on Computational Collective Intelligence* (pp. 613-624). Springer, Cham.
[10] Wang, L., & Shen, S. (2019). A decay model for the fundamental diagram of pedestrian movement. *Physica A: Statistical Mechanics and its Applications*, *531*, 121739.
[11] Migon Favaretto, R., Rosa dos Santos, R., Raupp Musse, S., Vilanova, F., & Brandelli Costa, A. (2019). Investigating cultural aspects in the fundamental diagram using convolutional neural networks and virtual agent simulation. *Computer Animation and Virtual Worlds*, *30*(3-4), e1899.
[12] Favaretto, R. M., Musse, S. R., & Costa, A. B. (2019). Fundamental Diagram Analysis. In *Emotion, Personality and Cultural Aspects in Crowds* (pp. 105-123). Springer, Cham.
[13] Alonso, B., Ibeas, Á., Musolino, G., Rindone, C., & Vitetta, A. (2019). Effects of traffic control regulation on Network Macroscopic Fundamental Diagram: A statistical analysis of real data. *Transportation Research Part A: Policy and Practice*, *126*, 136-151.
[14] Bosina, E., & Weidmann, U. (2018). Creating a generic model of the pedestrian fundamental diagram. In *18th Swiss Transport Research Conference (STRC 2018)*. STRC.

[15] Hoogendoorn, S. P., Daamen, W., Knoop, V. L., Steenbakkers, J., & Sarvi, M. (2018). Macroscopic fundamental diagram for pedestrian networks: theory and applications. *Transportation research part C: emerging technologies*, *94*, 172-184.
[16] Cao, S., Lian, L., Chen, M., Yao, M., Song, W., & Fang, Z. (2018). Investigation of difference of fundamental diagrams in pedestrian flow. *Physica A: Statistical Mechanics and its Applications*, *506*, 661-670.
[17] Vanumu, L. D., Rao, K. R., & Tiwari, G. (2017). Fundamental diagrams of pedestrian flow characteristics: A review. *European transport research review*, *9*(4), 1-13.
[18] Chen, J., Lo, S. M., & Ma, J. (2017). Pedestrian ascent and descent fundamental diagram on stairway. *Journal of Statistical Mechanics: Theory and Experiment*, *2017*(8), 083403.
[19] Bosina, E., & Weidmann, U. (2017, July). Defining the Pedestrian Fundamental Diagram. In *International Conference on Traffic and Granular Flow* (pp. 383-391). Springer, Cham.
[20] Cao, S., Seyfried, A., Zhang, J., Holl, S., & Song, W. (2017). Fundamental diagrams for multidirectional pedestrian flows. *Journal of Statistical Mechanics: Theory and Experiment*, *2017*(3), 033404.
[21] Wang, J., Boltes, M., Seyfried, A., Tordeux, A., Zhang, J., Ziemer, V., & Weng, W. (2017, July). Influence of gender on the fundamental diagram and gait characteristics. In *International Conference on Traffic and Granular Flow* (pp. 225-234). Springer, Cham.
[22] Huo, F., Song, W., Chen, L., Liu, C., & Liew, K. M. (2016). Experimental study on characteristics of pedestrian evacuation on stairs in a high-rise building. *Safety science*, *86*, 165-173.
[23] Das, J. B., Chattaraj, U., & Nayak, S. (2016). Studies on Pedestrian Fundamental Diagrams: Field Observation and Controlled Experiments.
[24] Fang, J., Qin, Z., Hu, H., Xu, Z., & Li, H. (2012). The fundamental diagram of pedestrian model with slow reaction. *Physica A: Statistical Mechanics and its Applications*, *391*(23), 6112-6120.
[25] Zhang, J., Klingsch, W., Schadschneider, A., & Seyfried, A. (2011). Transitions in pedestrian fundamental diagrams of straight corridors and T-junctions. *Journal of Statistical Mechanics: Theory and Experiment*, *2011*(06), P06004.
[26] Hoogendoorn, S. P., Campanella, M. C., & Daamen, W. (2011). Fundamental diagrams for pedestrian networks. In *Pedestrian and Evacuation Dynamics* (pp. 255-264). Springer, Boston, MA.
[27] Ren, X., Zhang, J., Song, W., & Cao, S. (2019). The fundamental diagrams of elderly pedestrian flow in straight corridors under different densities. *Journal of Statistical Mechanics: Theory and Experiment*, *2019*(2), 023403.
[28] Zhao, X., Xia, L., Zhang, J., & Song, W. (2020). Artificial neural network based modeling on unidirectional and bidirectional pedestrian flow at straight corridors. *Physica A: Statistical Mechanics and its Applications*, *5*, 123825.
[29] Zhang, J., Klingsch, W., Schadschneider, A., & Seyfried, A. (2012). Ordering in bidirectional pedestrian flows and its influence on the fundamental diagram. *Journal of Statistical Mechanics: Theory and Experiment*, *2012*(02), P02002.
[30] Chattaraj, U., Seyfried, A., & Chakroborty, P. (2009). Comparison of pedestrian fundamental diagram across cultures. *Advances in complex systems*, *12*(03), 393-405.
[31] Seyfried, A., Boltes, M., Kähler, J., Klingsch, W., Portz, A., Rupprecht, T., ... & Winkens, A. (2010). Enhanced empirical data for the fundamental diagram and the flow through bottlenecks. *Pedestrian and Evacuation Dynamics 2008*, 145-156.
[32] Seyfried, A., Portz, A., & Schadschneider, A. (2010, September). Phase coexistence in congested states of pedestrian dynamics. In *International Conference on Cellular Automata* (pp. 496-505). Springer, Berlin, Heidelberg.
[33] Hoogendoorn, S. P., Campanella, M. C., & Daamen, W. (2010, January). Macroscopic fundamental diagrams for pedestrian networks. In *89th Annual Meeting of the transportation research Board, Washington, DC*.
[34] Schadschneider, A., & Seyfried, A. (2009). Validation of CA models of pedestrian dynamics with fundamental diagrams. *Cybernetics and systems*, *40*(5), 367-389.