



Figure 6: Modified flow-space scatter diagram for pedestrian (Corridors-Downstairs-Upstairs)

3. Model

All the function models have passed the F-test (Confidence interval = 95%) through the SPSS. In literature, pedestrian simulation model covers two categories;

Discrete Models: pedestrian behavior by grid-based movement model that combines with a series of movement rules like constrained conditions. For instance, Cellular Automata (CA) model is given as the best example for this type of models. However, the model is not able to describe the differences of anthropomorphic measurement related to human body, and speed of different pedestrians during the simulation process [22]. The model fails due to the capacity of grids. Any type of steps related to any pedestrian need to be the integral multiples of the side length of a grid.

Continuous Model: Pedestrian flow dynamics describe pedestrian movement behavior by establishing continuous function pertain to pedestrian behavior characteristics. This model uses automated multi particle framework which assumes the individuals as the parts of a group who are able to think and response to the surroundings. According to Chen [16] social force model is widely used in pedestrian simulation due to its explaining capacity of the essence of pedestrian moving behavior.

Adding to all, there are two parameters in social force model: pedestrian size and its desired speed.

The social force model is not restricted by grid; on the contrary pedestrian size is relatively flexible. It can be fixed or stochastic. In pedestrian flow relation curves analysis, a 0.2 m² ellipse is taken into account. The relation between parameters of pedestrian flow curves and models show that when flow increases to the maximum, the space value shows the pedestrian minimum dynamic space, and when the flow reduces to 0, the space value shows the pedestrian minimum static space. On account of the regional differences of pedestrian characteristics and body sizes, the research results

in this study are only compared with the existing ones indicated in literature.

There are three methods to describe pedestrians in 2D simulation: round, ellipse, and rectangle. Although SF model usually uses ellipse or rectangle, ellipse is in fact more suitable to reflect pedestrians' real modality.

On the basis of human dimension table of Turkish adults used in calculation, the ratio of chest thickness to shoulder width for Turkish adults is accepted as 0.69 [17]; that is the elliptical semi-minor axis y and equals to the semi-major axis y which is multiplied by 0.6 Using the formula of elliptical acreage to transform the extent of occupied space into the extent of elliptical semi-major axis b , which is within the range of (0.47, 0.59) m.

The desired speed in SF model is usually fixed. In fact, it is affected by many factors because it is a kind of psychological desire. Even if the external condition is identical, the desired speed of pedestrian will still be different from each other.

4. Conclusion

In this study, pedestrian flow speed depends on the average value of 30% samples among all pedestrians. Therefore, the speed values on curves represent the speed of pedestrian flow which is considered as a whole. Because of the crowd effect, individuals in pedestrian flow will hope their speeds can catch up with the whole pedestrian flow, thus desired speed can be considered as the average speed of pedestrian flow.

Simultaneously, another important factor is time pressure, which is determined as;

$P(i) = t(i)/t(\max)$, where $p(i)$ denotes the time pressure of pedestrian i , $t(i)$ denotes the estimate travel time, pedestrian i thinks that it will take him $t(i)$ to reach his destination, and $t(\max)$ is the maximum usable time, with the restriction of trip aim and other factors, pedestrian should arrive at the destination within $t(\max)$.

When value $p(i)$ rises, the desired speed of pedestrian will rise, too. When the value of $p(i)$ is more than 1, the desired speed of pedestrian i will increase to a maximum value.

The primary target of such simulation is to accurately describe pedestrian flow characteristics in the real world. Relation between pedestrian flow parameter models of different facilities in the airport terminal building are established in this study, and then the parameters in social force pedestrian simulation model are calibrated. Pedestrian flow-density relation curves are fitted and models are established for corridors, upstairs, and downstairs. Pedestrian size and speed values of SF Model are determined. In the process of calibrating desired speed, time pressure is considered as an innovative factor.

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