

Experimental Investigation of Pedestrian Queue Formations before Different Types of Bottlenecks

ボトルネックの種類に応じた歩行者待ち行列形成に関する実験的分析

東京大学 生産技術研究所 大口研究室 (交通制御工学)

張嘉華 (with 井料美帆) <http://www.transport.iis.u-tokyo.ac.jp/>



Introduction

Pedestrian queuing behavior in front of bottlenecks is one key aspect of pedestrian dynamics. As highlighted in previous studies, features of pedestrian queues before different types of bottlenecks are dissimilar. Insights into similarities and differences of pedestrian queuing behavior for typical bottlenecks, such as narrow corridors, stairways and ticket counters, can be important for planning and design of public walking facilities.

However, no sufficient studies have been carried out so far to examine the diversity of pedestrian queuing behavior. In this study, a series of experiments are designed and conducted to explore the characteristics of pedestrian queues under different conditions.

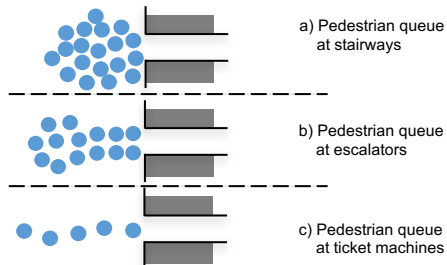


Fig.1 Schematic Illustration of different Queue Formations

Experiment

Experiment Scenarios

Four conditions with three bottleneck widths (0.8m, 1.0m and 1.2m) are designed in this experiment

- a) Free Flow (uncontrolled) FF
- b) Departure Control Slow DS
- c) Departure Control Fast DF
- d) Stairway SW

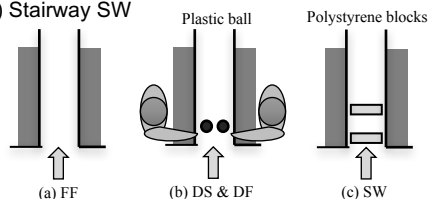


Fig.2 Schematic Illustration of Four Conditions

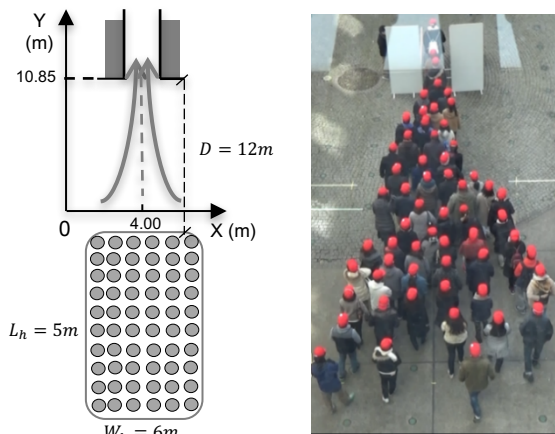


Fig.3 Experiment Configuration and one snapshot

Summary & Future Work

- As results suggest, pedestrians tend to form organized queues before bottlenecks with departure control (e.g. ticket counters where only one person can be served at a time).
- Besides, higher walking speeds are observed in the center section of the queue before extremely narrow bottlenecks while an opposite result appears before wider ones.
- Moreover, pedestrians prefer to take stop-and-go approaching strategy towards counters. In contrast, continuous moving at slower speed is more prominent in case of corridors or stairways.

As for future works, traffic waves of queue propagation are expected to be compared between different scenarios. Further, effect of pedestrian queues on macroscopic characteristics of pedestrian flow will also be confirmed.

Analysis Results

Lateral Distribution

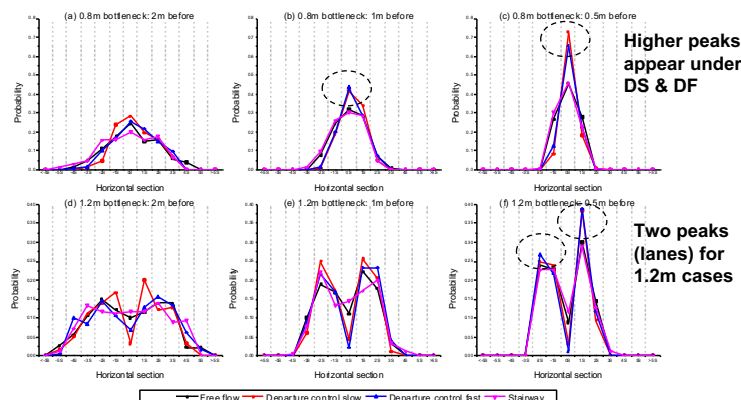


Fig.4 Probability of Lateral Distribution ($S = 0.24m$)

Pedestrians were found to prefer forming organized queues under departure control conditions (DS & DF). Especially before extremely narrow bottleneck (0.8m) which can only allow one person to comfortably pass, the tendency to form one-by-one queue became quite remarkable.

Walking Speed Transition

1. Spatial Distribution of Walking Speed

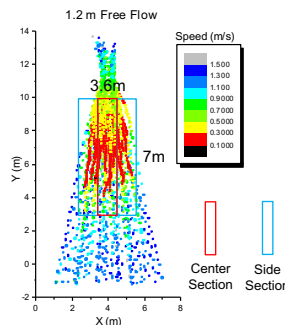


Fig.5 1.2m FF Trajectories

Table1 Space Mean Speed Comparison

Bottleneck Width	0.8m	1.2m
FF Center section \bar{v}_x (m/s)	0.347	0.507
FF Side section \bar{v}_x (m/s)	0.262	0.515
Difference (%)	-25%	+2%
DS Center section \bar{v}_x (m/s)	0.179	0.246
DS Side section \bar{v}_x (m/s)	0.118	0.271
Difference (%)	-34%	+10%
DF Center section \bar{v}_x (m/s)	0.265	0.351
DF Side section \bar{v}_x (m/s)	0.181	0.367
Difference (%)	-31%	+5%
SW Center section \bar{v}_x (m/s)	0.206	0.347
SW Side section \bar{v}_x (m/s)	0.155	0.380
Difference (%)	-25%	+9%

Space mean speed shows contrary results for 0.8m and 1.2m bottlenecks

2. Stop Frequency

A complete stop event is defined as the speed lower than 0.01m/s lasting for more than a second.

Stop ratio is the percentage of pedestrians who completely stopped at least once.

From Figure 6 it can be understood that for DS and DF, pedestrians prefer to stop-and-go rather than continuously moving slowly.

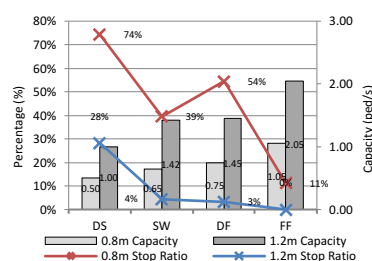


Fig.6 Relationship between Stop Ratio & Capacity