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Preface

These are the proceedings of the 13th Traffic and Granular Flow (TGF) Conference, which was held in Pamplona, Spain, from July 2 to July 5, 2019. TGF started in 1995 at Forschungszentrum Jülich (Germany) as a single time event, and has grown in 25 years to a conference series that is a reference in the field of pedestrian dynamics.

This time, more than 120 international researchers from different fields ranging from physics to computer science and engineering came together to discuss the state-of-the-art developments. The chosen dates (just before the worldwide known bull-running festivals of Sanfermín) and the variety of social events prepared by the organizers gave rise to a stimulating atmosphere that facilitated many discussions and the establishment of lots of new research connections.

In this edition, the hosting group, The Granular Lab of the University of Navarra, made an effort to encourage the participation of several members of the granular community, a discipline that was very present at the beginning of the conference series, but had practically disappeared from the main topics of the previous events. It was interesting to see that the connections between the behavior of granular media and other systems such as pedestrian dynamics are more tangible than ever. At the same time, there were several contributions from people working on emergent-related subjects such as self-propelled particles, data transport, swarm behavior, intercellular transport, and collective dynamics of biological systems.

This conference would not have been possible without the trust of Andreas Schadschneider and the rest of the TGF scientific committee. Of course, we are very grateful to those who shared with us the responsibility of organizing this conference: Daniel R. Parisi, Luis A. Pugnaloni Diego Maza, and César Martín-Gómez. A special thank goes to Silvia Olza, whose effort and dedication allowed the success of the conference. We would also like to state our recognition for the amazing performance of Iñaki Echeverría, Jose Ilberto Fonceca, Diego Gella, Bruno Guerrero, and Dariel Hernández, who were all Ph.D. students at the Granular Lab. Finally, we would like to acknowledge the logistic support of the Faculty of Sciences of the University of Navarra.

We are happy to contribute to the tradition of Springer proceedings of the Traffic and Granular Flow conference, and we are looking forward to the next edition, organized by K. Ramachandra Rao in New Delhi, India. Exceptionally, due to COVID19 pandemic and the delay of Pedestrian Evacuation Dynamics conference to the year 2021, the next Traffic and Granular Flow conference will take place in 2022.

Pamplona, Spain

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Part I
Pedestrian Dynamics

Chapter 1
Influence of Corridor Width and Motivation on Pedestrians in Front of Bottlenecks

Juliane Adrian, Maik Boltes, Anna Sieben, and Armin Seyfried

Abstract We present experiments on the behaviour of participants in front of a bottleneck. The waiting area was limited by a corridor of barriers leading straight to an entrance gate. We varied the width of the corridor and the degree of motivation of the participants to rush through the gate. We show that the density in front of the bottleneck grows with increasing corridor width and increasing motivation. Therefore, the velocity of individuals in the jam in front of the bottleneck is slower for wider corridors. Furthermore, it is shown that the flow through the bottleneck is controlled by the bottleneck width itself but is independent from the corridor width. The degree of motivation has, however, an influence on the flow rate through the bottleneck.

1.1 Introduction

Understanding the behaviour of crowds is important in order to draw up or to adapt safety regulations for buildings and event areas. People confronted with spatial bottlenecks either follow the social norm of queuing, they compete, or show a mixture of both behaviours. A competing behaviour leads to a high density of persons per square meter which can result in fatalities. A typical bottleneck situation, in which pushing might occur, is at the entrance gates to concert areas or events.

Sieben et al. [1] investigated the effect of different geometries of barriers in an entrance scenario. The experiments included two scenarios: an open waiting area without barriers and a corridor of barriers leading perpendicularly to the gates. In the first scenario, the participants arranged themselves in a semicircle around the gate. As soon as the gates were opened, they contracted until all interspaces were filled leading to high densities. In case of an upstreamed corridor, the participants arranged themselves in loose lanes before the gates were opened. After opening the gates, the

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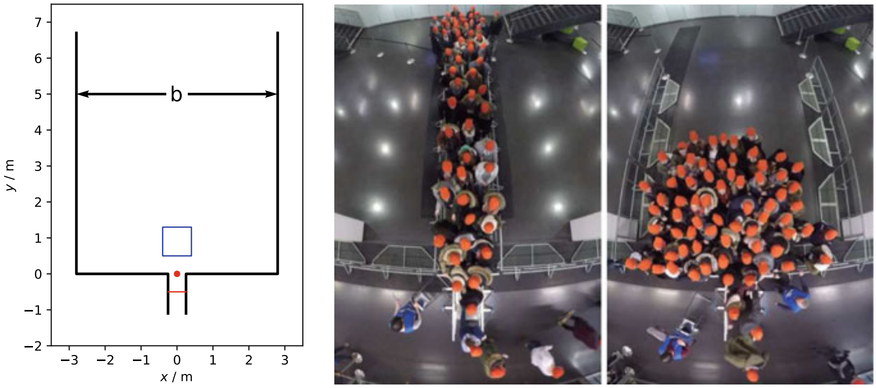

Fig. 1.1 Left: Sketch of the experimental setup with varying corridor width b. The red dot indicates the target at $x = 0$, $y = 0$, the red line is the target line for flow measurements, the blue square is the density measurement area. Centre, right: Screenshots of overhead video recordings at $t = 5$ s with high motivation of a run with $b = 1.2$ m (centre) and with $b = 5.6$ m (right)

densities were lower than in the first scenario. According to a questionnaire study, in which participants were asked to rate the scenarios after a presentation of video recordings of the experiments, the open space is perceived as less safe and more unjust than the corridor.

The results lead to the question to what extent the width of a corridor influences the participants behaviour in terms of physically measurable quantities, such as the density, and socio-psychological factors, such as the perception of social norms.

In this work, bottleneck experiments are presented focussing on the behaviour of persons in front of a bottleneck while their degree of motivation and the width of a corridor leading to the bottleneck is varied.

1.2 Methods

The presented experiments were carried out at the University of Wuppertal, Germany. As participants, university students were recruited at the end of their lectures. Due to the recruiting strategy, the number of participants varied. In the following, we concentrate only on runs with more than 40 participants.

The experimental setup is sketched in Fig. 1.1. A typical entrance gate with a width of 0.5 m served as bottleneck and simulated the entrance to a concert hall. The height of the gate was 1.18 m. Therefore, shoulder parts could be protruded over the structure. The waiting area was limited by barriers forming a corridor leading straight to the entrance. The corridor width were systematically varied from 1.2 m to 5.6 m.

All participants were asked to imagine that they are waiting in front of the entrance to a concert of their favourite artist or band. Each group of participants had to perform

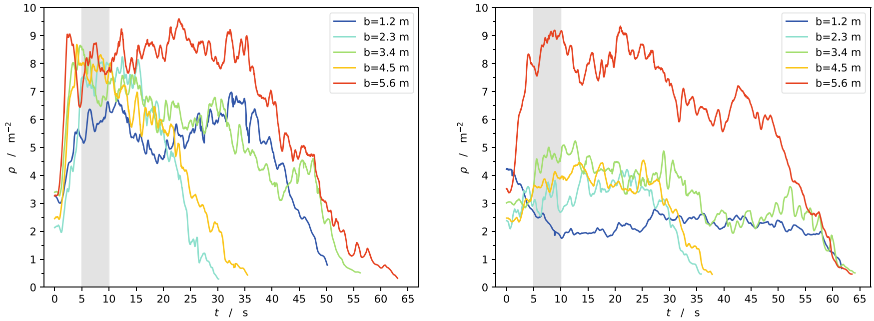

Fig. 1.2 Time series of the mean density ρ within the measurement area (see Fig. 1.1-left) for one experimental run for each corridor width. Left: high motivation, right: low motivation

two experimental runs in the same corridor width. In the first run they were told that, if they stand in the back, they can hardly see the stage or only on the video screen. So, they absolutely want to be standing next to the stage. Therefore, the motivation to access the concert as fast as possible was high. In the second run, the degree of motivation was reduced by the announcement that this time everybody will have a good view of the stage, but still they should enter the concert quickly. Even though the motivation of participants was different, we could not detect any obvious temporal decrease of motivation during a run (typically 30 to 60 s). However, we could in some cases observe that highly motivated participants pushed and passed the bottleneck earlier than participants with low motivation.

For all experimental runs, the individual head trajectories were automatically extracted from overhead video recordings following [2]. These trajectories are the basis for all data analysis presented in the following. The moment at which the entrance was opened is defined as $t = 0$ s.

1.3 Results

1.3.1 Influence of Corridor Width on Density

The personal space of each participant is defined as the area of the individual Voronoi cell being determined according to [3] using the software `JuPedSim` [4, 5]. Individual density is then given by the inverse of personal space.

Figure 1.2 shows the time series of the mean density within the measurement area (shown in Fig. 1.1) for one representative set of runs for each corridor width. We chose the measurement area to be small enough to fit in all corridor widths and to be in some distance (0.5 m) to the bottleneck in order to cover the area in which we expect the highest densities to occur.