

Can blind and visually impaired people evacuate safely in case of fire?

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Introduction

It is important to consider people with impairments!

- Approximately 1 out of 6 persons are living with a temporary or permanent impairment worldwide.
- Worldwide 285 million people are estimated to have a visual impairment.
- In the United States 2% of population have a visual impairment whereas it is 1.2% in Denmark.
- Studies in the United States have shown that the prevalence of people with visual impairments increases with age.
- Visually impaired people are to a greater extent actively taking part in different parts of society.

Introduction

It is important to consider people with impairments!

- Public buildings are accessible for all sections of the population – including people with disabilities. However accessibility does not ensure egressibility.
- Studies have shown that people with impairments are more likely to suffer during emergency situations.
- Changes in the characteristics of the building occupancies needs to be addressed while designing the safety systems.
- Laws, strategies and requirements on evacuation of people with disabilities is very country specific.
- A limited amount of data on blind and visually impaired people is currently available. It is therefore questionable if nowadays evacuation models are suitable for this segment of the population.

Occupancy types in Denmark

- In Denmark buildings are categorized according to type of occupancy.
- There are different requirements to the fire safety installations in buildings depending on the type of occupancy.
- Type of occupancy is divided into six categories where only one specifically describes people with impairments.
- The definition of the group prescribes that people with disabilities need to be rescued by the emergency service.

Objective

The objective of the current study is to increase the knowledge on evacuation characteristics of blind and visually impaired people and their interaction with the built environment. The study include measurements on:

- walking speeds horizontally and descending stairs;
- the influence of an increasing density on the walking speeds;
- the behavior during evacuation exercises and interaction with the built environment.



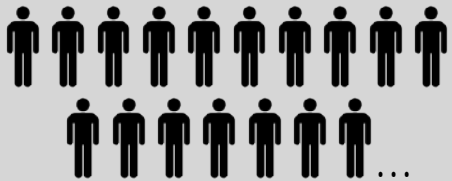
Method

Experimental setup

- Experiments divided into two parts;
 - Experiments in Denmark
 - Experiments in the United States
- Experimental period was from February to May 2011 and September 2013
- 57 participant, aged from 10 to 79 years old, took part in the experiments.
- No distinguishing in degree of visual impairment.

Method

Experimental setup

Type	No. of individuals	Instruction	No. of experiments
Single evacuation	One at a time 	Yes	20
Group evacuation (partial)	2-11 persons 	Yes	22
Full scale	All occupants 	No/unannounced	2

Method – Experimental setup

Test Locations

- 5 different buildings
 - Two-storey buildings (2)
 - Three-storey buildings (2)
 - Four-storey building (1)
 - No specific installations for visually impaired people
- In the Danish experiment the participants were familiar with the test environment. In the experiments performed in US they were in the building for the first time
- There were stairs and long corridors at all five locations which were used as means of egress.
- Cameras were temporarily installed at all locations. The number of cameras were different from location to location.
- Position of cameras were mainly in corridors and on stairs.



Results

Walking speed - horizontal

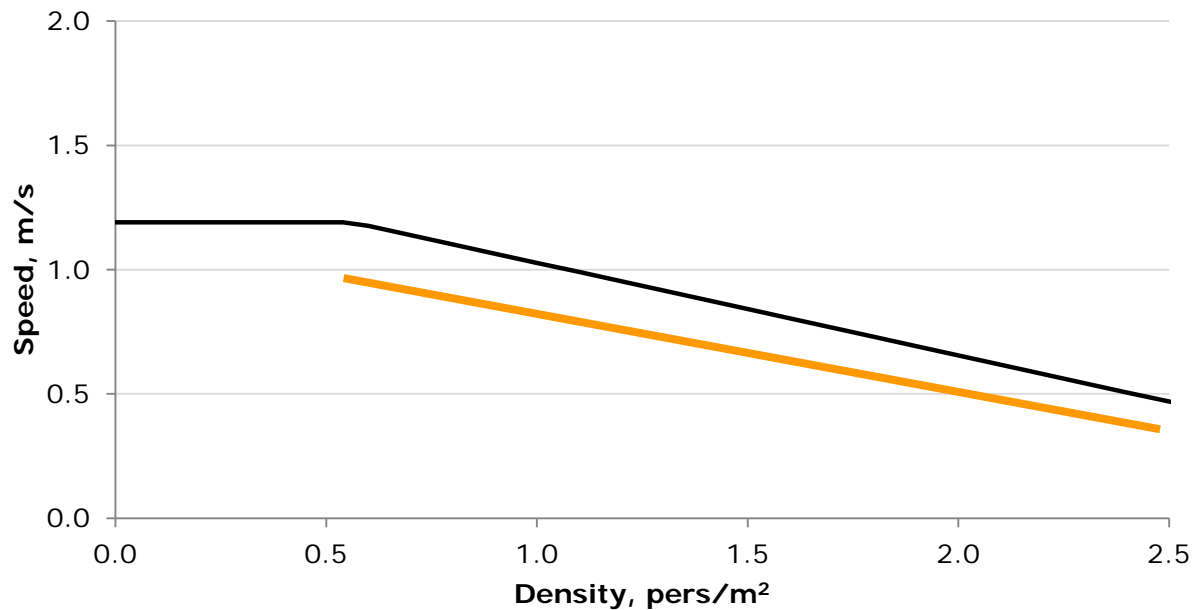
- Low densities
 - Large variation in results
 - Danish result lower than the theoretical value provided by Nelson and Mowrer (SFPE Handbook)
 - American result shows a higher value compared to N&M

	Mean	Min	Max	Std. dev.
Danish	0.98 m/s	0.35 m/s	1.72 m/s	0.36 m/s
USA	1.23 m/s	0.26 m/s	3.53 m/s	0.48 m/s
N&M	1.19 m/s			

Results

Walking speed - horizontal

- High densities:
 - Walking speed decreases with increasing density
 - Trend line is displaced downwards compared to N&M curve



Results

Walking speed - Descending stairs

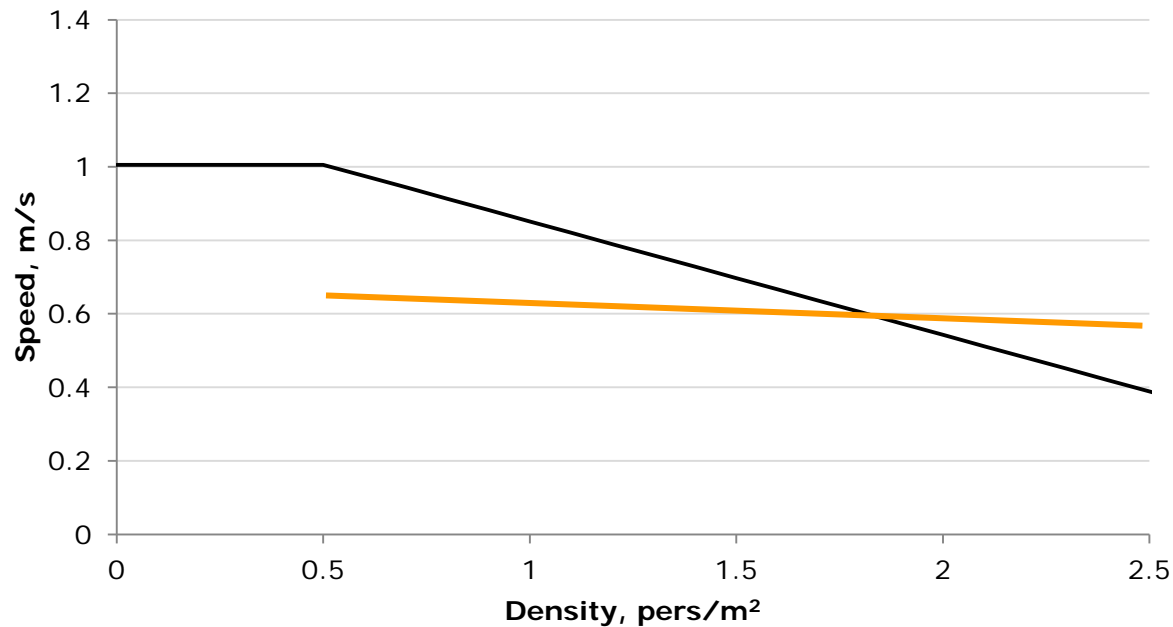
- Low densities:
 - Generally lower mean compared to the N&M value

	Mean	Min	Max	Std. dev.
Danish	0.78 m/s	0.54 m/s	1.25 m/s	0.17 m/s
USA	0.54 m/s	0.16 m/s	0.92 m/s	0.21 m/s
N&M	0.85-1.05 m/s			

Results

Walking speed - Descending stairs

- High Densities:
 - Less affected by increasing density
 - Shifted downwards compared to the N&M curve



Results

Findings – Building Design

- Lightning conditions
 - People with low vision benefit from a well lighted emergency path. This is not only beneficial for people with low vision, but also for people without visual impairments.
- Handrail
 - Continuing handrails also on landings
 - Awareness marking at start and end
- Differences in surface texture and color
 - Blind and people with low vision use their sense of feeling while they orientate in a building.
 - Different textures on e.g. wall and emergency exit would help to identify the exit.
 - Color differences could be beneficial for people with low vision to recognize exits.

Results

Findings – Building Design

- Door handle
 - Easy to operate
- Edge on steps
 - Marking on the edge of steps is essential for people with low vision to identify the first and last tread of a stair.
- Exit signs
 - Appropriate position and color
- Sound
 - Sound is used by blind and low vision people while they orientate
 - Background noise makes it more difficult for this group of people to orientate

Summary

- It is important to secure blind and visually impaired people in the same manner as able-bodied people.
- The experiments show that
 - There were found differences in the result for the Danish and American study
 - In general it is not conservative to apply the theory of Nelson and Mowrer for blind and visually impaired people.
 - The obtained results only show trends on walking speeds for this group and more data is needed to get statistical valid results.
 - Blind and visually impaired people are dependent on their surroundings for orientation – also in an emergency situation.

In a broader context:

EVACUATION OF MIXED GROUPS

Method

Full Scale Experiment

- Full-scale evacuation experiments with varying composition of the test group.
- The composition of the test groups were chosen with origin in the demographic profile of Denmark.
- Experiments were performed from a train in a tunnel.



- Four different setups - 46 participants in each setup – 100 participants in total



- 23 seated passengers and 13 standing in carriage and 10 standing in lobby area.
- Experiments were initiated by a spoken warning message from the communication system.
- The egress path was from the train to the main tunnel, from the main tunnel to the nearest transversal tunnel, and here to the safe place outside the tunnel.

Results

Total Egress Time

- The total egress time for the mixed groups are doubled compared to the homogeneous group.

Can blind and visually impaired people evacuate safely?

- The studies carried out shows that this segment of the population is more than willing to evacuate on their own in case of an emergency.
- People with low vision generally have a lower walking speed compared to able bodied people.
- People with low vision have a different walking path than observed for able-bodied adults
- Different safety installations can improve the orientation ability for blind and visually impaired people
- The evacuation time is dependent on the characteristics of the occupants.
- It is important to consider the vulnerable segment of the population while designing buildings.

THANK YOU FOR YOUR ATTENTION

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