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Evacuation of Heterogeneous Populations from High-rise Buildings

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Abstract

Evacuation from buildings is affected by the composition of the population present in the building. The current investigation is a comparative study on the evacuation of homogeneous and heterogeneous populations from a high-rise building using a hand calculation. Using this method, the limiting step was the determination of the reaction and decision times.

Introduction

Universal design is promoted by the UN and demands accessibility for all[1]. This has led to the installation of accessible toilets, access ramps, and elevators found in most building codes throughout the world [2]. As accessibility is a requirement, consequently, the ergressibiltiy of mixed groups need to be considered, when buildings are designed. Hence, the engineer has to consider the presence and the evacuation of heterogeneous groups in fire scenarios [3]-[6].

Evacuation characteristics of able-bodied people are dominantly documented in literature. Accounting for heterogeneity complicates the prediction of evacuation performance of a population, as a variety of factors need to be known and considered. Among these are different walking speeds, reaction and decision times, route choices and interaction between able-bodied and impaired [7].

Method

With the increasing need of space to live and to work, accompanied by the already crowded major cities, the issues regarding fire safety in buildings with several floors only become more and more relevant. That is the reason why the case of the current study is a high-rise office building. Assumptions and data from literature will be used to determine the Required Safe Egress Time of one of the floors in the building using. The case study will utilize hand calculation methods and will also try to reflect on the layout of the floor.

The case study set out to show a difference in evacuation time from a homogeneous versus a heterogeneous population. The calculations have been seen to be redundant as a reduction in walking speed of disabled would result in a higher evacuation time. The following assumptions are made:

Homogeneous population:

- The travel speed is governed by density.
- The density is assumed evenly spread on the egress paths
- The reaction time is set to 3 minutes
- Walking distance is chosen conservatively as the longest path.

Heterogeneous population:

- The travel speed of impaired may not exceed the speed of able-bodied.
- The density is assumed the same as for the homogeneous population.
- The reaction time is set to 4 minutes
- A composition of the population with respect to sight-, hearing-, and movement-impairments are taken from Danish data.
- The wheelchair users will escape with the fire elevator.
- The rest of the impaired will escape the same way as the able-bodied.

Conclusions

Introducing the reaction time in the estimated evacuation time will create a difference of 2 minutes. This is not a significant change considering the multitude of assumptions that have been made. Factors such as congestion or changes in flows resulting from the wheelchairs are not explored. Knowledge of behavior with assisted escape and more data on walking speed data is needed for heterogeneous groups and their subgroups.

References

[1] Steinfeld, E., & Mailsel, J. (2012). Universal design: creating inclusive environments. Hoboken, John Wiley & Sons, Inc.

[2] BR 2018, http://bygningsreglementet.dk/

[3] Elder, T. S., and BusuttilA. (1996). Fire fatalities in elderly people, Age and Ageing 25(3): 214.

[4] Kose., S. (1999) ,Emergence of aged populace: who is at higher risk in fires? Fire and Materials 23(6): 337-340.

[5] Leth., P. M. (1998)Omkommet ved brand ,The Department of Forensic Medicine, Aarhus, Denmark, Aarhus University, PhD thesis.

[6] Manley, Y. S. K., K. Christensen, and A. Chen. (2011) ,Modeling emergency evacuation of individuals with disabilities in a densely populated airport, Journal of the Transportation Research Board, 2206(1): 23-38.

[7] Sørensen, J.G., Dederichs, A.S.Evacuation from a Complex Structure – The Effect of Neglecting Heterogeneous Populations,Transportation Research Procedia, Volume 2, 2014, Pages 792-800, ISSN 2352-1465,https://doi.org/10.1016/j.trpro.2014.09.089.