# Abstract

**Conditions in a building during the evacuation of people with disabilities**

Ensuring both accessibility of buildings for people with disabilities and their safe evacuation conditions is a significant challenge, increasingly addressed in daily life. National regulations impose an obligation on building owners to ensure accessibility for everyone. However, there is still a lack of appropriate solutions. Building owners face serious challenges as ensuring the safety of people in the building and their safe evacuation is a priority.

In this doctoral dissertation, the author undertakes a comprehensive analysis of the topic, starting with an assessment of the conditions that can occur during fire development, using computational fluid dynamics tools. This includes experimental studies of evacuation from a public building, considering the evacuation of a person with a disability, testing the proposed solution of an evacuation chair, and creating an evacuation model in a simulation program with the implementation of actual movement speeds of selected user populations. The author introduced several modifications to the model created in a popular simulation program to demonstrate that it is possible to model populations of people with disabilities and to manipulate program settings to most accurately replicate results from real evacuation trials.

The conducted studies allowed for the analysis of conditions on evacuation routes during a fire. Through the analysis of selected scenarios, the available safe egress time (DCBE) was determined, which, due to exceeding critical parameter safety thresholds, was approximately 2 minutes. Experimental studies provided evacuation times from the building for selected populations – fully able-bodied individuals, a temporarily disabled person using crutches, and an individual being evacuated using an evacuation chair. The studies clearly indicated that using an evacuation chair improved the evacuation process. Based on the average speed in the corridor and on stairs, it was observed that the evacuation chair's speed in the corridor was approximately 42% higher than that of a person using crutches. On stairs, depending on the type of staircase, the improvement ranged from approximately 17% to even 50%.

Experimental studies determined the required safe egress time (WCBE), which is the time needed for evacuees to reach a safe location outside the building. Depending on the population, this time ranged from 83 seconds for able-bodied individuals, 143 seconds for a person evacuated using an evacuation chair, to 159 seconds for a person using crutches.

The movement speeds of different populations were implemented into the evacuation model. The author created a model reflecting the actual geometry of the building and its users. To obtain the most accurate simulation results, especially concerning the evacuation of people with disabilities, the author manipulated model settings, ultimately achieving satisfactory results. The best replication of real-world conditions for different populations was achieved with the following assumptions:

- Uniform distribution for corridor speed and minimum stair speed, normal distribution for delay time – for fully able-bodied individuals,
- Normal distribution for corridor speed and minimum stair speed, regardless of the distribution for delay time – for a user using crutches,
- Constant average corridor speed and stair speed depending on slope, according to SFPE data, normal distribution for delay time – for the assisting team and the person transported using an evacuation chair.

The differences between the evacuation times of various populations compared to experimental studies ranged from 1.2% to 11.5%. The best replication was achieved for the user evacuated using the evacuation chair.

By comparing DCBE and WCBE times along with a detailed analysis of simulation and fire development model results, it was concluded that all individuals in the danger zone would evacuate before conditions deteriorate, preventing further evacuation.

The analyses conducted allowed for identifying the main challenges posed by the obligation to ensure safe evacuation for all individuals, regardless of physical or mental condition, as well as available solutions for both final evacuation support and initial considerations.

The author believes that the research conducted will contribute to improving the development of solutions guaranteeing people with special needs the possibility of safe evacuation equal to that of fully able-bodied individuals.

**Keywords:** conditions on evacuation route, evacuation of people with disabilities, fire, FDS, Pathfinder