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Safety evacuation in building engineering design by using BuildingExodus

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Abstract

The crowd motion and the evacuation process in a building engineering design were simulated by BuildingExodus tool when a combustible dust layer fire happened in this building. It focused on the effect of number of exits and population on time of evacuation, and evacuation efficiency of each exit by modeling the building. The simulation results were shown that the evacuation process would become much easier with the increase of exits and decrease of population. It was found that there was a linear relationship between number of population and time of evacuation. In the case study, the maximum allowable number of population was 2970. The evacuation efficiency of WN-1ST, FS2_1ST and DOOR7 was far better than FS_1ST and ES_1ST

Keywords: Building engineering; dust layer; fire; safety evacuation; simulation

1. Introduction

Development of building spaces with increasingly larger and more geometrically complex areas were rapid recently in China. These types of building include teaching& laboratory building, department stores, and concert venues, and are always crowded with people especially in the holidays or active days [1]. However, accidents such as fire, toxic gas release and so on, always threaten human lives in these buildings. If the crowd fails to escape from a building in time, due to failure of obstacles' avoidance or wrong exit selection, people may be injured and killed **[2].**

Several big fires had happened in these large buildings in China. For example, a big fire occurred in Zhongshan, Guangdong, China on 25 December 2005, losing 26 lives and causing 11 injuries [3]. Therefore, safety evacuation of a group of pedestrians from the hazardous areas is still a major issue. In a certain building, due to the absence of data from real evacuations, a suitable modeling or simulation method may be required in order to analyse how the complexities of the building layout may effect a potential evacuation of the occupants [4-6]. After that, some measures can be taken to evacuate people from the danger zone through exits within the shortest possible time, and to help evacuation missions to be carried out efficiently and effectively [6-8].

Since building fire accidents in the college happened frequently in recent years, the aim of present work is to study safety evacuation under the condition of combustion of dust layer in a certain teaching- Lab building by using BuildingExodus tool. It focused on the effect of number of exits and people within the building on the time of evacuation. The simulation can be used for the design on building fire protection and prevention, or safety

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management of such buildings.

2. Simulation tool

Nowadays, more than 22 computer programs for modeling crowd motion and the evacuation process are designed, such as EXIT89, EXODUS, EGRESS, SIMULEX and so on [4,9]. Gwynne et al. [5] made a critical review of the capabilities of 22 different simulation models.

BuildingEXODUS is developed by fire safety engineering group in the University of Greenwich, and is a suite of software tools designed to simulate the evacuation of large numbers of people from a variety of enclosures. BuildingEXODUS codes take into consideration people- people, people- fire and people- structure interactions. As a group of pedestrians make their way out of the enclosure, or are overcome by fire hazards such as heat, smoke and toxic gases, the model can track the trajectory of each individual. The buildingEXODUS model comprises five core interacting sub-models, which are the Occupant, Movement, Behavior, Toxicity and Hazard sub-models. The progressive motion and behavior of each individual was determined by a set of heuristics or rules [9]. In a whole, for a given building configuration, type of occupancy and specific scenario, the tools can provide valuable information for fire specialists in performing fire safety engineering studies.

3. Scenario description

As a case study, a teaching& powder metallurgy Lab was selected for simulation. It was a multi-purpose four-story building whose functions include classroom, laboratory, and test center. The fire resistance classification was second grade. Distribution of eight exits and population in this building was shown in Table 1. It has seven exits in the first floor (Fig. 1，DOOR7 was located at the second floor.). There were large crowds of people which often have many tests in the fourth floor especially at the end of semester. Moreover, some scientific experiments are always conducted in this building, such as dust ignition& flame propagation, powder metallurgy and so on, and they have great hazards of fire & explosion. There 80 percent or more of the population is student, and the other is teacher. The characteristic property and composition of the population was shown in Table 2.

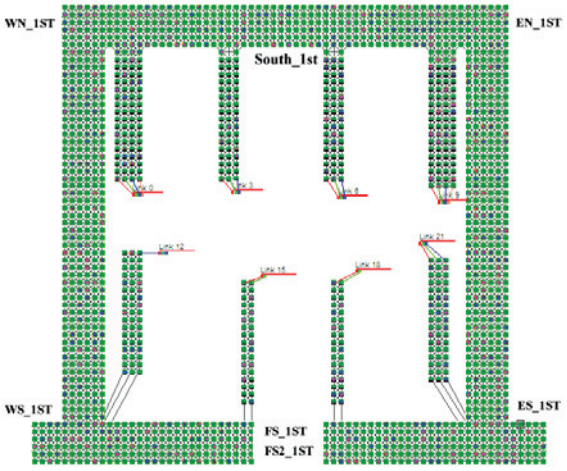

Fig. 4 Construction of the first floor