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Study on law of personnel evacuation in deep buried metro station based on the characteristics of fire smoke spreading

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Abstract

With the improvement of people's life and the rapid development of urban traffic, the subway has the advantages of convenience and celerity, to a large extent, which greatly eases the traffic congestion phenomenon. With the attendant, the safety of the subway environment becomes vital. Many engineers focus on the study of the fire prevention and safety to escape. In this paper, a comprehensive study on the fire smoke spreading and the evacuation of the people in the deep buried metro model is carried out. First, the deep buried metro model is modeled on the STEPS software, and the personnel evacuation rule is obtained. According to the evacuation situation, the corresponding fire smoke monitoring points are built in the fire scenario which is set up on FDS+Evac software. Then, FDS+Evac program is used to simulate the evacuation in a fire scenario. It has not only analyzed the real time effect that the characteristics of fire smoke spread have on the personnel evacuation, but also improved the accuracy of the subway fire safety evaluation.

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Keywords: deep buried metro station, fire smoke spreading, personnel evacuation, STEPS, FDS+Evac

Nomenclature

HRR	the heat release rate
Q	quantity of heat
i	variable

1. Introduction

With the increase of the population of the city, the traffic jam is becoming more and more serious. The underground transportation system is the first choice for most people to travel. Because of the huge traffic, the subway will cause serious damage if it is dangerous. Among the many factors that threaten the safety of subway, the fire is the most influential factor. In case of subway fire, large quantities of smoke are likely to spread rapidly to entire subway station due to stack effect and space confinement. It has been found that passenger's evacuation path usually coincides with smoke spread path. Smoke would reduce occupants' visibility and cause fatalities by suffocation. Many catastrophic fires in subway stations caused heavy casualties.

The deep buried metro, a special internal building structure, when the danger occurs, the timely and effective personnel evacuation guidance becomes particularly important, can avoid the loss of life and property. The personnel evacuation is a complex subject which refers to structure of the building, fire development and human behavior in the building. With the rapid progress of computer technology, a large number of evacuation models have been developed and researches in this field begin to enter a new stage. In present, several researches have been carried out to study the personnel evacuation in fire

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scenario. However, the real time effect of smoke spread on personnel evacuation in the deep buried metro has rarely been conducted. This paper will set up the personnel evacuation of deep buried metro by STEPS to summary the rule. Then a comprehensive model which contains smoke spread and personnel evacuation is set up by FDS+Evac.

The research group is undertaking a project of Beijing Municipal Science and Technology Commission: Deep subway station fire research design, simulation and application. This paper will be based on the deep buried metro's SketchUp model to study. Finally, fire simulation and evacuation simulation are performed simultaneously to evaluate life safety in the deep buried metro station by FDS+Evac software.

2. Emergency evacuation model by STEPS

2.1. Introduction to STEPS

STEPS (Simulation of Transient Evacuation and Pedestrian Movements) is a three-dimensional evacuation software, can simulate the office area, shopping centers, sports and subway stations, etc., these places are: simple transportation in the normal circumstances, rapid evacuation in emergency. By creating a real-time three-dimensional simulation graphical form that is easy to understand, it can help to identify the preferred export and natural bottlenecks, but also can predict the evacuation time and route according to different working conditions.

STEPS simulation software model is based on the fine grid system. Software is to divide the building into a myriad of small grid system, and then the wall and other obstacles to the passage of obstacles, different types of personnel can be placed in advance to the designated area [1].

2.2. Overview of evacuation simulation model

Because the SketchUp model of the deep buried metro is difficult to be used in STEPS, in order to facilitate the simulation, the station model should be simplified according to certain rules [2]. The model of the deep buried metro station is established by STEPS, in which some accessory structures are ignored, such as the station house, the track zone, the platform screen door and the ticket office on the lobby floor. The impact of the pillars on the platform, the automatic ticket barriers and metal fences on the lobby floor are considered in the model.

The deep buried metro station has three storeys below the ground level, 158.75m long×130.5m width×44.5m high as shown in Fig 1. There are three choices for passengers from platform to the station hall.

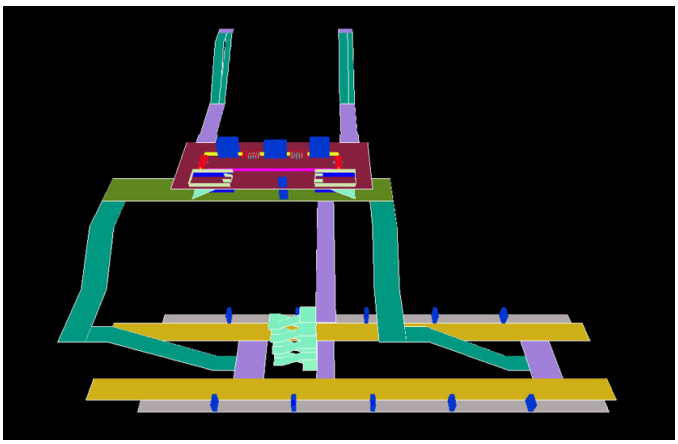

Fig. 1. The geometry of the deep buried metro station.

2.3. The characteristic parameters for simulation

1. Occupant features. According to the default setting in STEPS and the actual situation, people group is located in the subway by the male and female ratio 1:1. And the characteristic parameters of occupants set in STEPS is shown in Table 1.