



10th International Symposium on Heating, Ventilation and Air Conditioning, ISHVAC2017, 19-22 October 2017, Jinan, China

Personnel evacuation research of subway transfer station based on fire environment

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Abstract

This paper used "FDS+Evac" simulation model to analyze the platform transfer area fire scene. It focused on the effect of the interaction between the fire and personnel evacuation on the result of evacuation. Through the analysis of evacuation with fire or without fire and fire scene in different conditions, the important influence of the fire smoke to evacuation personnel psychological and physiological aspects was obtained. Results have shown that effect of fire environment on evacuation is significant, mainly reflected in the following three aspects: extending the evacuation time, limiting the scope of activities and changing the personnel evacuation route. The results of this study will help guide the evacuation design of underground space on fire situation.

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Peer-review under responsibility of the scientific committee of the 10th International Symposium on Heating, Ventilation and Air Conditioning.

Keywords: subway transfer station; smoke flow; people evacuation; FDS+Evac

1. Introduction

On fire situation, evacuation channel's visibility will be greatly reduced because of the smoke propagation, which will increase the evacuation time, and aggravate casualties. High temperature smoke will not only affect people behavior, but also people's eye and central nervous system can suffer different degrees of damage. The walking speed of the people under smoke situation is basically inversely proportional to the concentration of the smoke. In 2009, Cao Shouhua, Yuan Zhenzhou focused on collected data of the passenger traffic characteristics of the subway

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station in Beijing, established model contains of the pedestrian flow, speed, density relationship, analyzed the distribution of passengers on the platform and evolution of the crowd's crowding at entrances and exits[1]; In 2012, Zhang Yimin, Zhang Lu analyzed the difficulty of evacuation and rescue operations[2]; Wang Zhilei studied on personnel evacuation program comparatively under tunnel fire scene by the software FDS+Evac in 2015. They believed in the evacuation when train into the station better than in tunnel[3]. In 2016, Li Xiuxia, Niu Lei, et al. studied the spatial effect of fire spread on personnel evacuation route planning by using point set theory and 9 cross topology models.

However, previous studies have not considered FDS+Evac evacuation behavior on no fire condition. Actually, comparison evacuation in fire and no fire situation is more able to explain fire smoke's important influence on people evacuation from psychological and physiological aspects. This paper used FDS+Evac to study the distinction between evacuation in fire and no fire situation, at the same time combined real-time effects to analyze the impact of smoke under fire evacuation.

2. Methods

2.1. System design

This paper selected a typical complex structure as the research object, which described "+" type transfer station with island-platform, the 3D model shows in Figure. 1. The station consists of two subway lines (A, B line), total of three layers, each layer height is 3.5m. 3rd underground and 2nd underground subway platforms install full-high safety door. Both the two layer platforms width are 12m, the station East-West length (A line) is 148m, the screen door full-length is 120m; north-south length (B line) is 150m and screen door length is 120m.

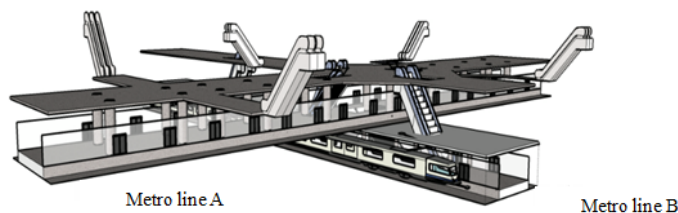


Fig. 1. Model diagram of a subway transfer station

Taking into account the fire source settings, we selected more unfavorable fire source position to personnel evacuation, assuming that the fire occurred in the 2nd underground platform layer, which is shown in figure. 2. At present, some researchers at home and abroad have verified the maximum heat release rate of luggage fire is not more than 2MW, considering large passenger traffic on the transfer station, the maximum heat release rate of portable combustible material is 3MW. The fire source is set to t^2 curve, and the burning object is set to kerosene.

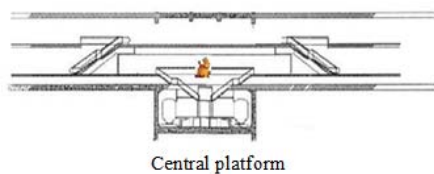


Fig. 2. The fire position of the station

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