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Numerical Simulation & Scene Experiment of Metro Tunnel with Crossover Interval under Fire Conditions

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Abstract

In this study, numerical simulation and scene experiment with metro crossover interval are performed to estimate the effect of ventilation model and the position of the most unfavorable smoke removal on passenger's life safety under fire conditions. Firstly, based on STESS (Metro Thermal Environment Simulation Software), a network model of smoke removal is established with the crossover interval of metro line 10 (Between Wen De Road Station and Yu Shan Road Station), which discusses the effect on smoke flow and fire spread in different indicators, including fire source position and intensity, the number of platform and interval fan used as dealing with emergency. Secondly, combined with FDS (Fire Dynamics Simulator) technology, a three-dimensional field model of metro station with crossover interval is set up, which contributes to the smoke's variation of temperature field and velocity field as well as concentration field can be simulated and analyzed under fire conditions. And then the model of fire conditions is measured and verified with crossover interval in scene experiment. On the basis of above all, the study puts forward where each opening fan is positioned and what the number is needed, satisfying the requirements of smoke removal and providing references in metro crossover interval at the same time.

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Keywords: Crossover interval, Fire conditions, Ventilation, Numerical simulation ;

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1. Introduction

It is often seen metro fire accidents in recent years. During the period of 1903-2004, there were 34 cases of metro fire accidents, among which the proportion of metro fire accidents was 43.5% [1] because of driver's disoperation and train's short circuited. Once fire occurs, the driver should be docked at the train station to facilitate the passengers' evacuation. But if the train can only stay in the tunnel, serious safety accidents would be prone to happen. Because the metro is a relatively confined space, and most of the used materials of vehicles are flammable, even if not flammable materials (such as glass fibre and plastic hardening materials), in the case of encountering high temperature, the materials would generate dense smoke and toxic gases, contributing to passenger's poison or asphyxiation. [2] Hence, controlling and exhausting smoke effectively have become an important part of the metro fire rescue.

There are lots of researches on ventilation in metro under fire conditions [3][4][5], including fire simulation and smoke behaviour or movement [6][7][8]. However, the situation, escaping to platform is more appropriate, is not researched sufficiently on ventilation with metro crossover interval at present. Because the airflow or air leakage in the crossover interval can both connect uplink and downlink, the existing ventilation model may not satisfy the requirements of wind velocity 2m/s [2] under fire conditions. Therefore, the investigation of scene experiment and fire simulation to estimate the effect of ventilation system on passenger's safety and to avoid heavy casualties is needed.

2. Methods

In this study, wind velocity and temperature are firstly measured. According to the obtained values, the appropriate accident ventilation model is obtained by changing the number and position of opening fans by STESS simulation. Then, FDS simulation will be used to verify the visibility, temperature and carbon monoxide concentration until getting the best ventilation model under fire conditions. The specific process is shown in Figure 1.

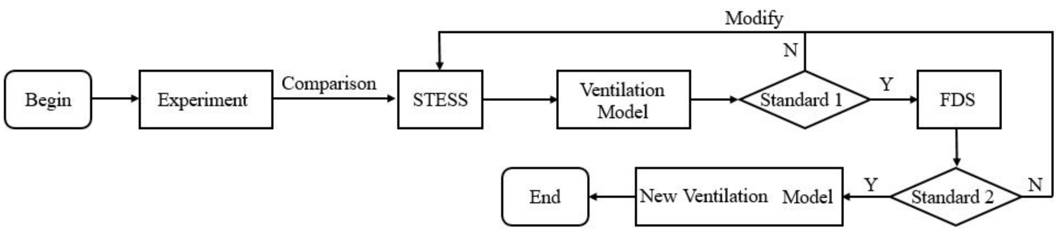

Fig. 1. *Flow chart or design of research.*

2.1. Scene experiment

Though the wind velocity should be measured on the basis of the measurement method in circular section, it is suggested that the upper part of the tunnel is equipped with ducts, the lower rails and the side other facilities through scene investigation, so the section of wind velocity and temperature can be simplified from a circle to a rectangle. Each section has nine measuring points, each measuring point is read 3 times, and then the average is the corresponding average wind velocity and temperature. The main measuring instruments are shown in Table 1 below.

Table 1. The main measuring instruments.

Number	Equipment	Accuracy
1	RHLOG temperature self - recording instrument	±0.3℃
2	AR826 hotline anemometer	±0.1m/s