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# Effect of Platform Screen Doors on Mechanical Smoke Exhaust in Subway Station Fire

Da-yan LI, Guo-qing ZHU*

*School of Safety Engineering, China University of Mining and Technology, Xuzhou, 221116, PR China*

**Abstract**

In subway station fires, the most immediate threat to passengers' life is not the direct exposure to fire, but the smoke inhalation with hot air and toxic gases. Thus, the study on efficient smoke control is of theoretical and practical significance. In this paper, the fire dynamics simulator (FDS) is used to study the effects of open mode of platform screen doors (PSDs) on mechanical smoke exhaust in subway station fire. The fires is located on the middle of the platform. And the results indicate that open platform screen doors on both sides of the platform, can not only reduce the gas temperature, but also improve the efficiency of mechanical smoke exhaust, which are beneficial to safety evacuation.


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*Keywords*: subway station fire, platform screen doors, mechanical smoke exhaust

**Nomenclature**

| | |
|---|---|
| $b$ | plume radius (m) |
| $c_p$ | specific heat at constant pressure ( kJ / (kg·K) ) |
| g | acceleration due to gravity (m/s$^2$) |
| $\dot{m}_\rho$ | the plume mass flow rate (kg/s) |
| $t_s$ | required safe egress time (s) |
| $t_c$ | required time of the smoke layer fall to smoke screens (s) |
| z | height above the point source (m) |
| $z_0$ | virtual origin (m) |
| D | diameter of the fuel source (m) |
| $H$ | height of smoke screens (m) |
| $\dot{Q}$ | total energy release rate (kW) |
| $\dot{Q}_C$ | convective enegry release rate (kW) |
| $T_0$ | centerline temperature (K) |
| $T_\infty$ | ambient air temperature (K) |
| $V$ | the exhaust capacity of exhaust fan ((m$^3$/s)) |

*Greek symbols*

* Corresponding author. Tel.: +86-158-5249-6101; fax: +86-516-8359-0598.
*E-mail address:* grace_ldy@163.com

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|---|---|
| $\rho$ | flue gas density (kg/m$^3$) |
| $\mu_0$ | plume velocity (m/s) |

## 1. Introduction

Fire threat is a major concern in subway stations due to platform confinement and stack effect. With the continuous improvement of operational safety requirements of city subway station, the platform screen doors (PSDs) almost became the subway construction standards. The original intention of PSD is to protect passengers' safety, they also have a certain effect on subway station's fire conditions. The most immediate threat to passengers' life is the smoke inhalation with hot air and toxic gases in case of subway station fire. Thus, the study on effect of PSDs on smoke exhaust in subway station fire has become one of the most essential research directions of fire safety science.

According to past research, many experiments were carried out to investigate smoke movement under various smoke-control operating modes in platform of a subway station and innovative achievements were accomplished. The smoke generator and heater are used for simulating the smoke movement at subway station fires. Many researches have been carried out to predict smoke behavior or movement and related topics in underground space such as tunnel [1-4] and subway system [5-7]. A Computational Fluid Dynamics (CFD) analysis was performed to demonstrate the capability of the emergency ventilation system to control the smoke and heat generated by fire in a station equipped with PSDs [8]. Jae Seong Roh et al. [9], performed fire simulation and evacuation simulation to estimate the effect of PSDs on passenger's life safety in a subway train fire. The results showed that the passengers in platform with PSDs have more available time than passengers in case without PSDs in modeled subway station.

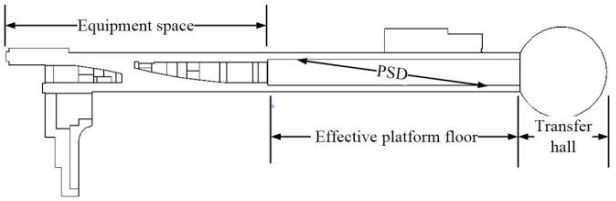
In this study, the fire dynamics simulator (FDS) is used to study the effect of open mode of PSDs on mechanical smoke exhaust in subway station fire. The subway station is island-platform station with three stories below the ground. This paper assumes that the fire is located on the middle of the platform and three calculation scenarios are designed.

## 2. Fire modeling

In order to estimate the effect of open mode of PSDs on mechanical smoke exhaust in subway station fire, simulations of smoke movement in case of subway station fire are carried out by using the fire field model FDS, which was developed by National Institute of Standards and Technology (NIST). The model has been verified by many domestic and foreign full-scale fire experiments. The FDS describes fire-driven flows based on field model. The spatial distribution and changes over time of status parameters were obtained by using partial differential equation. When the simulation runs, study area is divided into a number of control volume, and they are solved by iteration of differential equations. The governing equations for FDS code can be found in McGrattan [10].

### *2.1. Subway station geometry*

The subway station chosen by the paper is island-platform station with three stories below the ground, which is 335 m long, 94 m wide and 15 m high. Platform floor is in basement 3, station hall is in basement 2, and station exit and commercial streets are in basement 1. Transfer hall and transfer channel are on the right side of station, the left side is equipment space. There are four stairs and four escalators between platform floor and station hall, effective platform floor is 140 m long, 14 m wide and 4.5 m high. The plane models of station are shown in Figure 1.




(a)