

Concerns on Fire and Ventilation Provision in Subway System

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Abstract

Numerous incidents on fire and poor ventilation provision were observed in the local underground subway in the past 30 years. Some even occurred in crowded train compartments. Service was occasionally suspended due to electrical signal fault and other unknown reasons. These two key incidents under crowded conditions are proposed to be considered carefully.

1. Introduction

Vast numbers of passengers travel through the large local railway system every day [1]. A review on the incidents in Hong Kong in the past 32 years was reported [2]. The causes of incidents on fire safety and inadequate ventilation provision due to system faults and others such as power fault, electrical signal fault and platform screen door temporary malfunctions should be reviewed carefully. Safety must be treated as the first objective to be achieved by the railway system operation in the future. Two points on the railway systems are observed:

- Fire hazards which occurred quite a number of times, affecting over 70,000 passengers since 1979.
- Inadequate ventilation provision in crowded train compartments when the system suspended due to any reason including electrical signal fault.

Consequently, high loading rate of occupants and long evacuation time in crowded stations, particularly those located deep underground must be properly addressed.

2. Ventilation Provision in a Train Compartment

Very high occupant load was observed every day during rush hours as in Fig. 1. The ventilation rate required would become much larger than the calculated value as raised years

ago [4]. No data on indoor air quality in train compartments and subway stations was released to the public under crowded conditions [4].

3. Fire Incidents

Fire in subway systems may be caused by many reasons. The fire-related incidents on record that occurred in the past 30 years were summarized [2]. Although no casualties or serious fire disasters up to a scale similar to that of the Daegu subway train fire [5] that occurred on 18 February 2003, total number of passengers affected was over 70,000. Most of the fire incidents were small fires or smoke caused by power fault or human operation mistake or negligence. Even the arson fire with a bigger ignition source [6,7] than the South Korean one [5] did not lead to disaster. However, luggage carried by passengers [8] appears to increase. This must be reviewed.

4. Timeline Analysis

The ‘timeline analysis’ or timeline approach [9] was commonly applied in performance-based design (PBD). The Available Safe Egress Time (ASET) was simulated by fire models by referring only to reported data on tenability criteria on thermal exposure and smoke. The Required Safe Egress Time (RSET) was estimated with evacuation software. ASET and RSET are then compared with the safety margin (ASET – RSET) evaluated. However, there have been serious concerns [10,11]:

- Scenarios with small design fires were used to get long ASET even for many projects on crowded and big halls.
- Human behavior under local conditions was not investigated in depth to get RSET.
- Low occupant loading would give short RSET.
- The safety margin (ASET – RSET) is only taken as a percentage of RSET, not several times of RSET.
- ASET used to be estimated without smoke toxicity of chemical species, only carbon monoxide was included to give long ASET. RSET was simulated by evacuation model without including human behavior of local citizens, the estimated RSET might be very short.

5. Conclusions

Safety in stations, tunnels and train vehicles should be taken as the top priority of operating the railway system. Fire hazard and inadequate ventilation provision have been two key

incidents frequently experienced in the local railway system since 1979. Subway suspension occurred recently in Singapore [12] also illustrated that ventilation provision in crowded train compartments should be watched. Some passengers trapped inside had to break the window for getting better ventilation !

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Fig. 1: A crowded local subway station