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A Study on Development of Air Screen to Prevent Smoke-Spreading

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Extended Abstract

The importance of smoke control system is very critical to deal with the smoke that threatens the people's life as well as disrupts the firefighting activities in the event of fire. According to NFIRS (National Fire Incident Reporting System) the fatality due to smoke inhalation accounted for more than 70% of the total [1].

The study on measures to prevent the smoke from spreading between the large space and connection space in a large building was conducted [2]. The study included the smoke screen effect depending on air jet velocity in air screen type system [3] as well as the study on smoke-spreading prevention performance and major design parameters through the model test and numerical analysis in situation that the smoke keeps rising along the stairs [4]. In addition, the study on air jet both at upper level and lower level of evacuation passage in a bid to block the smoke from penetrating into the evacuation passage [5] was conducted. On the other hand, the study to review the need for preventing smoke spreading and the phenomenon was also conducted [6].

In this study, air screen system to prevent the smoke from spreading is proposed and jet stream was measured using a full-scale test device and 3D numerical analysis was also conducted at same condition and furthermore, smoke control effect of air screen was analyzed by numerical approach using the air jet velocity of the nozzle and smoke movement velocity.

Air screen system comprising of mechanical air supply system, air nozzle, exhaust hood and mechanical exhaust system was proposed. To deal with the smoke spreading force, rational design of air jet velocity and flow rate is important. According to the full-scale test, when the air jet velocity at the nozzle was 30 m/s, mean velocity at 1m below the nozzle at the center, left and right side was 7.9 m/s, 5.2 m/s and 6.2 m/s, respectively. And when air jet velocity was 20 m/s and 10 m/s, it was 5.0 m/s, 3.4 m/s, 4.1 m/s and 2.6 m/s, 1.6 m/s, 2.0 m/s, respectively. As a result of reviewing the air stream at the center in air screen system, the test result and numerical analysis result were agreed each other up to 2 m below the nozzle, but at the exhaust hood inlet, test value was higher than numerical analysis value and air jet from the nozzle in numerical analysis was slightly higher than actual flow. When air jet velocity was 20 m/s and smoke movement velocity was 1 m/s, 12.9 % of the smoke flowing from the top right passed through the air screen while 76.3% was blocked by the air screen. When air jet velocity was 20 m/s and smoke movement velocity was increased from 1 m/s to 3 m/s, the smoke blocked by air screen was decreased from 76.3 % to 34.1 % and the smoke passing through the air screen was increased from 12.9 % to 52.4 %. The smoke exhausted through exhaust hood was 10.4 ∽ 13.5 %, indicating insignificant change. When the air jet velocity was 30 m/s, smoke blocking by air screen was increased from 20 m/s and thus as more smoke was blocked at same smoke flow rate condition.

The number of buildings vulnerable to the fire is on the rise in line with the construction of larger and higher buildings in urban area and thus more effective measures to protect the human's life shall be developed and applied to the works.

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