

A NOVEL SMOKE CONTROL SYSTEM FOR TALL ATRIUM

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ABSTRACT

Potential fire and smoke hazard of a very tall atrium is investigated by applying computational fluid dynamics (CFD). Results show that smoke extraction on the fire floor (and smoke floor) while pressurizing the upper and lower floors can provide a more efficient smoke control and management system. As a result, evacuation time and visibility can be increased. In a super tall atrium, smoke may not be able to move up to the ceiling and tend to move to the sideways due to insufficient buoyancy. Traditional atrium's smoke control system with smoke extraction on the top of the atrium and make-up air injection to the bottom of the atrium, may not extract the smoke in the middle of the atrium satisfactorily, particularly when there are surrounding corridors. This paper shows using CFD a novel smoke management system of tall atrium in Hong Kong.

1. INTRODUCTION

Atrium inside a building is an old architectural concept for about two thousand years. This concept has been developed and extended to modern buildings. Current trend of atrium design provides an 'ideal' external environment to the occupants with a large undivided space. The major problem for fires in atrium is hot and toxic gases accumulating and go down in the atrium, spreading throughout the atrium, and affecting escape routes, even there is no fire.

Generally, atrium design is classified into three types which are cubic, flat and high [1, 2]. Cubic and flat atria have been widely applied in U.K. and Europe. For tall atria, it can be commonly found in Hong Kong and U.S.A.. The objective of this paper is to evaluate the performance of smoke exhaust system inside a tall atrium and develop such a 'fire engineering' approach, which can underpin a simple guide for engineers in the smoke management for tall atrium.

2. LOCAL AUTHORITY

For fire services installation for atrium design, local authority concerns the following issues:

- All sprinklers at adjacent corridor and atrium floor should be fast responded.
- Smoke free corridor should be provided.
- Smoke barrier, fire shutters and fire glass should be considered.

- Vertical spread of smoke should be studied.
- Mean of escape route should be detail designed.

A novel smoke control system to provide a smoke free corridor for escape is evaluated in this paper.

3. SIMULATIONS ON THE ATRIUM FIRE ENVIRONMENT

In the present investigation, the CFD package PHOENICS version 3.1 with the FLAIR menu [3] was used to study smoke movement inside a tall atrium of height 86 m as shown in Fig. 1. Also, the indoor environmental parameters and fire induced air flow have been simulated by two simulations F1 and F2.

The atrium is within a main development project, located at the new reclamation development site in Kowloon. The project will be one multipurpose building, built on a podium over the new railway station and will consist of a hotel, commercial office building, retail areas and car park. A super tall atrium hotel is located at the lower part of the building. High sleeping risk is expected and detail investigation of the fire safety is necessary.

F1 was simulation with a 0.5 m by 0.5 m by 0.5 m and 0.5 MW fire located in the upper level of the corridor adjacent to the atrium as in Fig. 1. Simulations were performed in a Sun Sparc Ultra workstation. The velocity, temperature and smoke concentration were calculated to evaluate the performance of the smoke inside the tall atrium.

The results in velocity, temperature and smoke concentration are illustrated earlier [4]. The smoke have been cooled by the ceiling of the atrium and go down. High smoke concentration and temperature on the top of the atrium means that smoke will quickly fill the space above the fire floor including the adjacent corridors.

F2 was simulation with 0.5 m by 0.5 m by 0.5 fire of 5 MW from located at the atrium floor as in Fig. 1. Results predicted an atrium in Fig. 2 High smoke concentration and temperature are also existed on the top of the atrium.

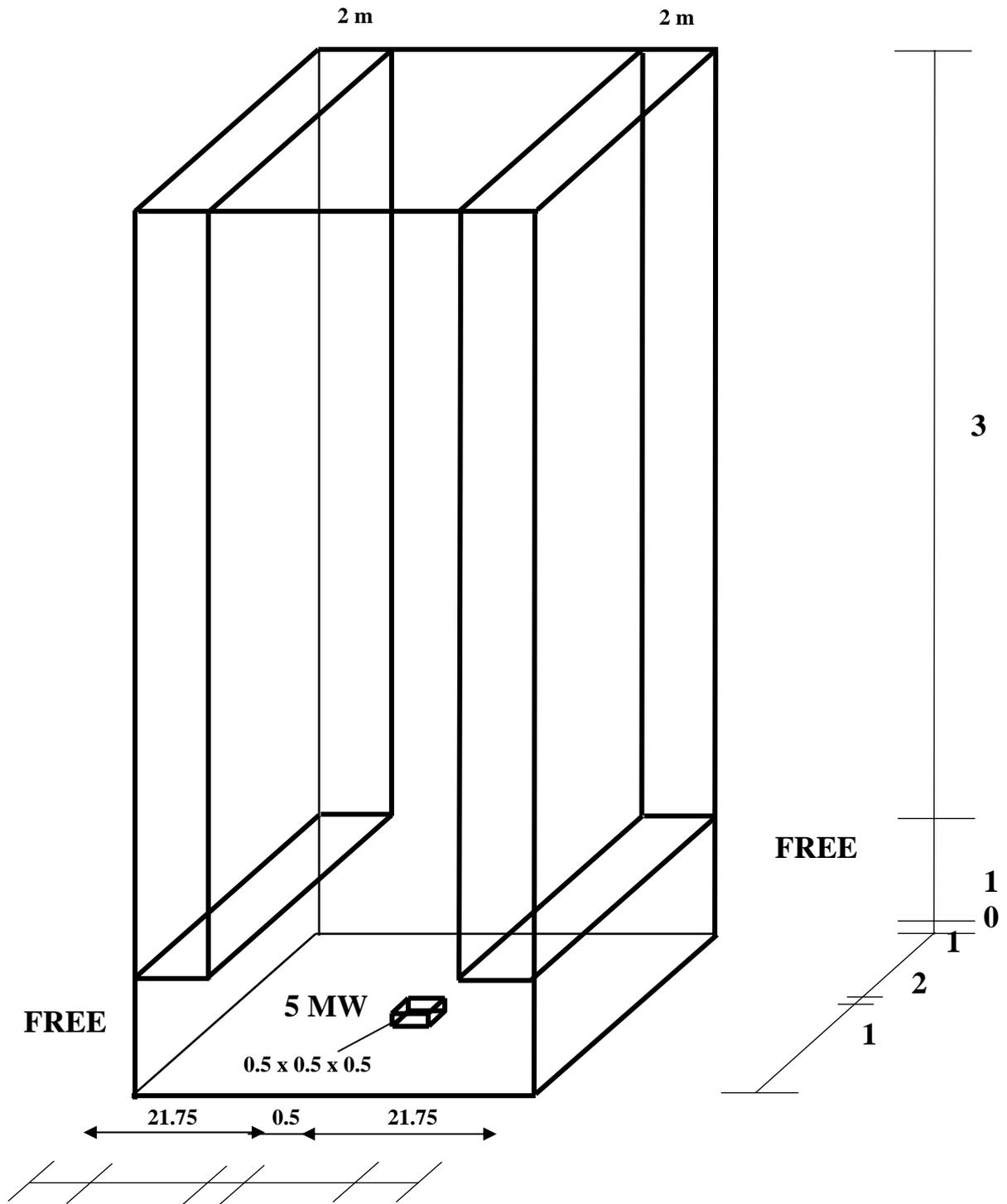


Fig. 1: F2: 5 kW Fire at atrium

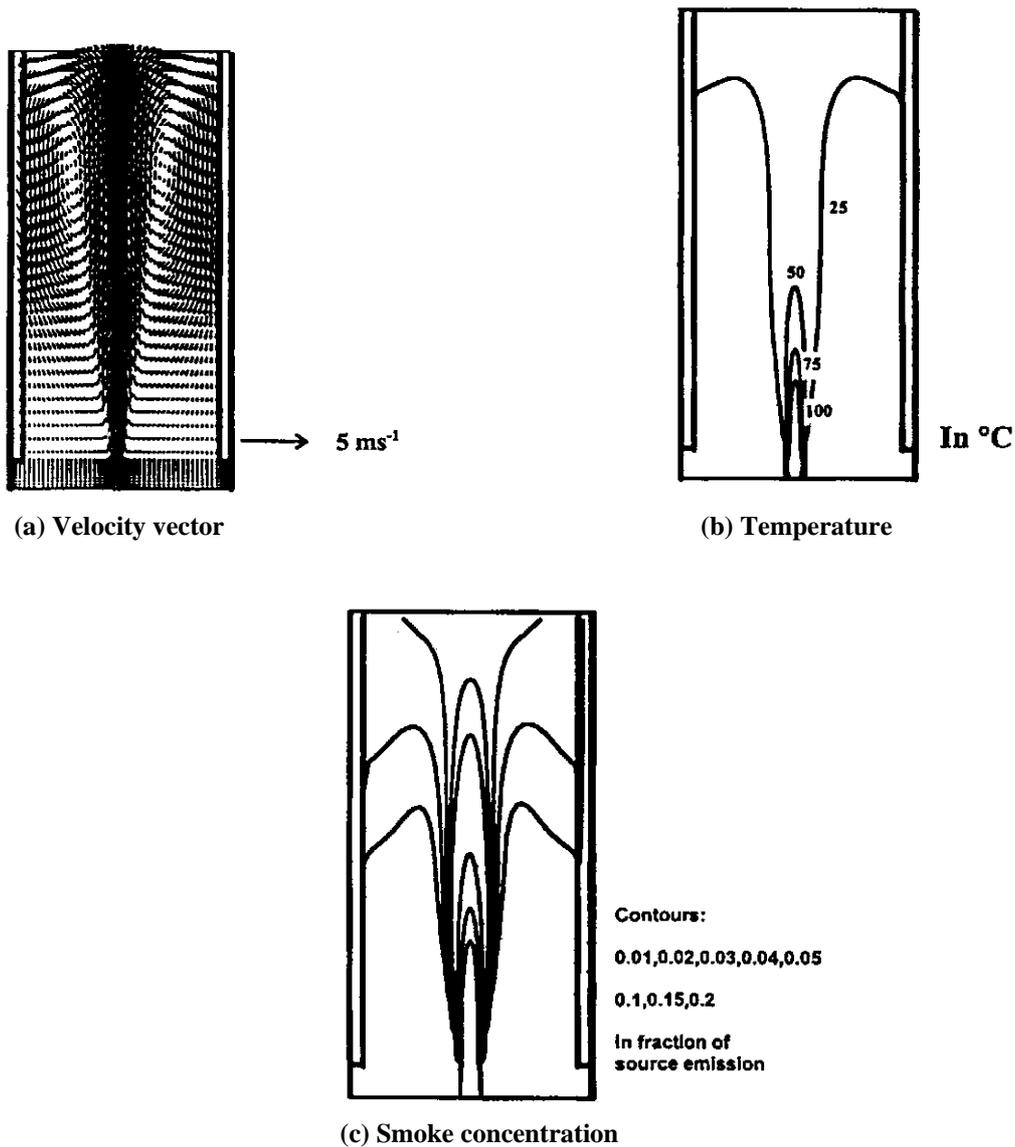


Fig. 2: Predicted results for F2

4. NOVEL SMOKE CONTROL SYSTEM FOR TALL ATRIUM

Present study shows that smoke will accumulate on the upper part of the fire floor. Smoke extraction on the fire floor and the top of the atrium, and positive pressurization of the remaining floors are effective in resisting the smoke from entering the escape route. Our idea is that the smoke extraction outlet, with high performance smoke extraction system, is located between the corridors and the atrium void to extract the smoke immediately. At the same time, supply air will provide the make air to and pressurize the corridor to create a smoke free

corridor for the occupants. Fig. 3 shows the novel smoke control system when fire in occurs corridor (adjacent to atrium). Side wall sprinkler, and smoke canopy with 'cabin concept' are adopted to protect the atrium floor. The side wall sprinklers can be activated by Infra red sensors as there will not be sufficient heat to activate his sprinkler system.

For the atrium hotel, high fire load density is not expected. Moreover, applying the 'cabin' concept [5] for enclosing those heat sources such as electric ovens and gas cookers to confine the fire size can be incorporated to the atrium design.

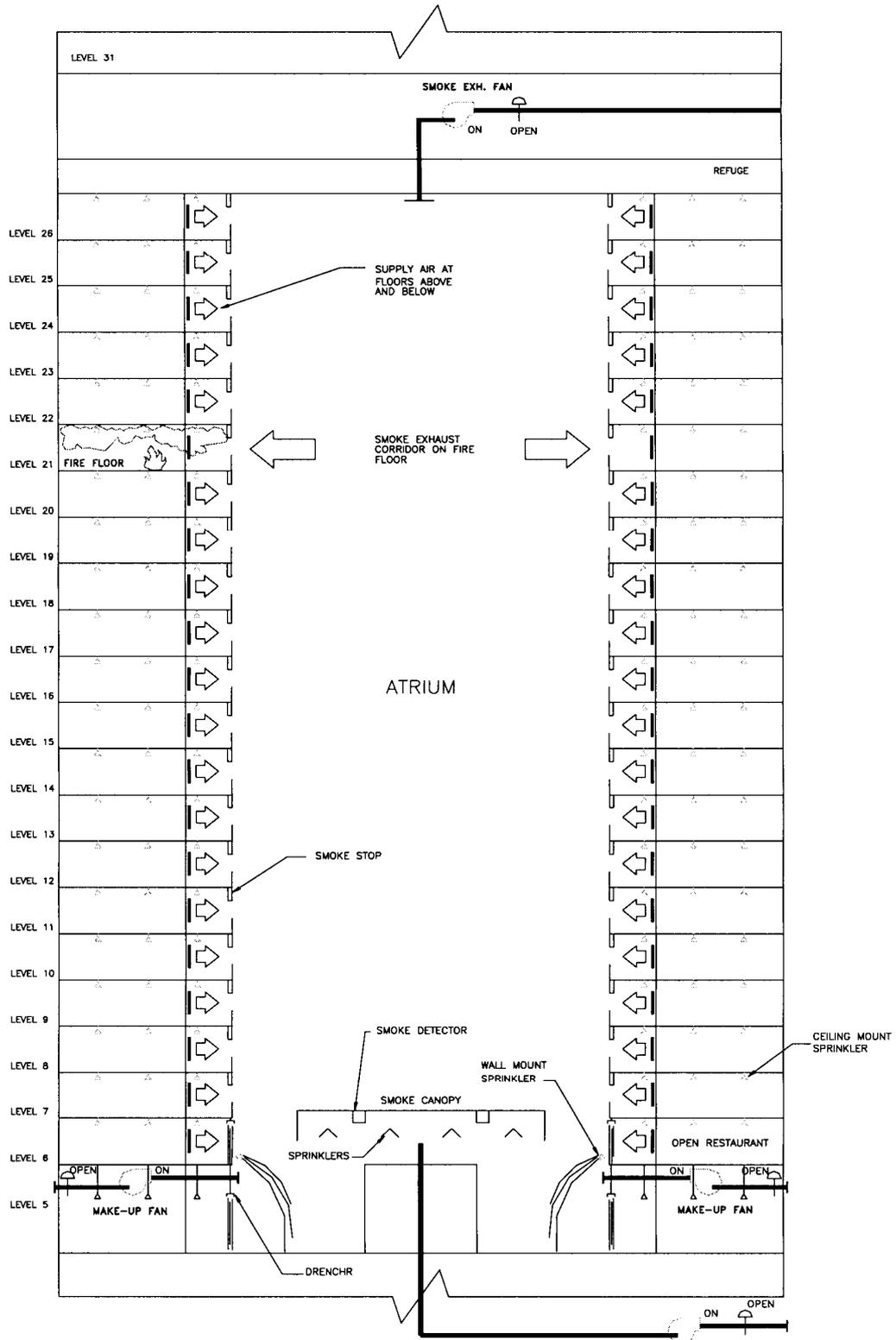


Fig. 3: Atrium (smoke exhaust operation) Fire at adjacent corridor

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5. CONCLUSIONS

Results of the present study indicate that high performance smoke extraction on the fire floor and the top of the atrium, and pressurization of the remaining floors can provide an effective smoke management system for the tall atrium. In addition, other measure such as 'cabin' concept can be incorporated into the atrium design.

ACKNOWLEDGEMENT

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