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Editorial

Preface: Special Issue on Fire-Induced Smoke Movement and Control

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1. Introduction

Generally, fires in confined spaces have more intense burning behaviors than open-space fires due to the accumulation of heat and smoke released by fires. Driven by increasingly rapid globalization and urbanization, the immense growth of building density and complexity has led to larger fire frequency and consequences [1]. This significant increase in building fire risks have raised extensive concerns about smoke transportation and control on confined-space fires through full-scale experiments [2,3], reduced-scale experiments [4,5], numerical simulations [6,7], and statistical analysis [8]. Today, a vast number of studies on fire-induced smoke movement and control are being continuously reported. It is important to provide state-of-the-art insight and strengthen the field knowledge. This Special Issue presents a collection of 12 papers that address the fundamental and practical problems of smoke movement and control in various buildings.

2. Descriptions

This Special Issue consists of research in two directions, including smoke movement under natural ventilation and smoke control, and establishes a firm foundation for future research in the field of fire-induced smoke movement and control. Efforts regarding smoke transportation law under natural ventilation have been emphasized due to the importance of determining fire hazards. The dimension effect (curvature [5] and tunnel width [9] of underground space; deck spacing of the double-deck bridge [10]) and fire source effect (heat release [5,11] and fire source location [9]) on two-dimensional temperature distribution and smoke layer entrainment have been quantified. These scientific articles contribute fire hazard assessment methods to various building fires.

Recently, the contribution to smoke control is increasing continuously. Smoke control can be divided into passive and active control technologies. In terms of passive smoke control, a methodology for field testing of smoke control properties of fire facilities [12] and an optimized natural ventilator [13] have been provided. Compared to the passive method, active control receives more attention. Aiming at the underground space, ship engine room, and large atrium, the important design parameters of smoke control system, such as smoke vent layout [4], smoke exhaust rate [4,9,13], air supply volume [14], and longitudinal ventilation velocity [15–17], have been well-addressed. Advances in smoke exhaust strategies have the potential to guide engineering practice.

3. Future Research Direction

Although considerable progress has been made on fire-induced smoke movement and control, much work remains to be conducted. Firstly, the limitations of CFD fire modelling as the widely used method, i.e., long-lasting and costly computation, are still significant [1,18], and AI (artificial intelligence) with high-performance computing will have wider applications. Secondly, in recent years, extreme weather (e.g., heavy rainfall [19,20]) is becoming increasingly prevalent with global warming. The boundary condition describing the extreme environment will not be disregarded when studying confined space fires. Last but not least, with the complex interconnected infrastructures (e.g., underground interconnected tunnel [5,9]) and green buildings [21] rapidly emerging, the characteristics of smoke transportation in these new buildings will need to be concerned in the future.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Zhang, T.; Wang, Z.; Zeng, Y.; Wu, X.; Huang, X. Building artificial-intelligence digital fire (AID-Fire) system: A real-scale demonstration. *J. Build. Eng.* **2022**, *62*, 105363. [CrossRef]
2. Long, Z.; Liu, C.; Yang, Y.; Qiu, P.; Tian, X.; Zhong, M. Full-scale experimental study on fire-induced smoke movement and control in an underground double-island subway station. *Tunn. Undergr. Space Technol.* **2020**, *103*, 103508. [CrossRef]
3. He, J.; Huang, X.; Ning, X.; Zhou, T.; Wang, J.; Yuen, R. Stairwell smoke transport in a full-scale high-rise building: Influence of opening location. *Fire Saf. J.* **2020**, *117*, 103151. [CrossRef]
4. Tao, L.; Zeng, Y. Effect of different smoke vent layouts on smoke and temperature distribution in single-side multi-point exhaust tunnel fires: A case study. *Fire* **2022**, *5*, 28. [CrossRef]
5. Tao, H.; Xu, Z.; Zhou, D. Investigation of the temperature beneath curved tunnel ceilings induced by fires with natural ventilation. *Fire* **2022**, *5*, 90. [CrossRef]
6. Jafari, S.; Farhanieh, B.; Afshin, H. Numerical investigation of critical velocity in curved tunnels: Parametric study and establishment of new model. *Tunn. Undergr. Space Technol.* **2023**, *135*, 105021. [CrossRef]
7. Liu, Q.; Xiao, J.; Cai, B.; Guo, X.; Wang, H.; Chen, J.; Zhang, M.; Qiu, H.; Zheng, C.; Zhou, Y. Numerical simulation on the effect of fire shutter descending height on smoke extraction efficiency in a large atrium. *Fire* **2022**, *5*, 101. [CrossRef]
8. Zhang, Y.; Huang, X. A review of tunnel fire evacuation strategies and state-of-the-art research in China. *Fire Technol.* **2022**. [CrossRef]
9. Liu, Q.; Xu, Z.; Xu, W.; Tagne, S.M.S.; Tao, H.; Zhao, J.; Ying, H. Study of the heat exhaust coefficient of lateral smoke exhaust in tunnel fires: The effect of tunnel width and transverse position of the fire source. *Fire* **2022**, *5*, 167. [CrossRef]
10. An, W.; Shi, L.; Wang, H.; Zhang, T. Study on the effect of bridge deck spacing on characteristics of smoke temperature field in a bridge fire. *Fire* **2022**, *5*, 114. [CrossRef]
11. Lin, W.; Liu, Q.; Zhang, M.; Cai, B.; Wang, H.; Chen, J.; Zhou, Y. Numerical simulation on smoke temperature distribution in a large indoor pedestrian street fire. *Fire* **2023**, *6*, 115. [CrossRef]
12. Hung, H.; Lin, C.; Chuang, Y.; Luan, C. Application development of smoke leakage test apparatus for door sets in the field. *Fire* **2022**, *5*, 12. [CrossRef]
13. Li, M.; Qiang, Y.; Wang, X.; Shi, W.; Zhou, Y.; Yi, L. Effect of wind speed on the natural ventilation and smoke exhaust performance of an optimized unpowered ventilator. *Fire* **2022**, *5*, 18. [CrossRef]
14. Wu, X.; Zhang, Y.; Jia, J.; Chen, X.; Yao, W.; Lu, S. Experimental and theoretical analysis of the smoke layer height in the engine room under the forced air condition. *Fire* **2023**, *6*, 16. [CrossRef]
15. Xu, Z.; Zhen, Y.; Xie, B.; Tagne, S.M.S.; Zhao, J.; Ying, H. Study on the effect of blockage ratio on maximum smoke temperature rise in the underground interconnected tunnel. *Fire* **2023**, *6*, 50. [CrossRef]
16. Na, W.; Chen, C. A study on the evacuation spacing of undersea tunnels in different ventilation velocity conditions. *Fire* **2022**, *5*, 48. [CrossRef]
17. You, W.; Kong, J. Feasibility analysis of cross passage ventilation and smoke control in extra-long submarine tunnel. *Fire* **2022**, *5*, 102. [CrossRef]
18. Wu, X.; Zhang, X.; Huang, X.; Xiao, F.; Usmani, A. A real-time forecast of tunnel fire based on numerical database and artificial intelligence. *Build. Simul.* **2022**, *15*, 511–524. [CrossRef]
19. Fan, C.; Luan, D.; Bu, R.; Sheng, Z.; Wang, F.; Huang, X. Can heavy rainfall affect the burning and smoke spreading characteristics of fire in tunnels? *Int. J. Heat Mass Transf.* **2023**, *207*, 123972. [CrossRef]
20. Luan, D.; Bu, R.; Sheng, Z.; Fan, C.; Huang, X. Experimental study on the impact of asymmetric heavy rainfall on the smoke spread and stratification dynamics in tunnel fires. *Tunn. Undergr. Space Technol.* **2023**, *134*, 104992. [CrossRef]
21. Zhang, X.; Aram, M.; Qi, D.; Wang, L. Numerical simulations of smoke spread during solar roof fires. *Build. Simul.* **2022**, *15*, 561–570. [CrossRef]