Hot Issues in Fire Engineering

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Wind Effect on Static Smoke Exhaust System in Shopping Malls

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Concern on Static Smoke Exhaust System

As raised before [1], static smoke exhaust system with natural vent is starting to be more commonly installed to protect tall and big halls in the Far East than before. Buoyancy of the smoke layer is the driving force for removing smoke. However, air pressure perturbations due to unstable air motion or thermal environment in the surroundings would affect the system performance. This is particularly obvious for systems with horizontal ceiling vents installed next to tall buildings under strong wind [2]. Smoke can be pulled down by wind action if the hall is located near to an adjacent vertical wall. The importance of evaluating this part carefully while designing static smoke exhaust system, particularly for crowded deep underground railway stations, was pointed out recently [2].

Scale Model Experiment

Scale model experiments by research students supervised by the principal author [3] indicated clearly the adverse effect of filling up the hall with smoke. A scale model of a hall with natural vent was constructed as in Fig. 1. The effect of different wind speed and separation distance of the hall from a vertical wall was studied. Without an adjacent building, wind effect can exhaust smoke from the natural vent at a faster rate. However, with a vertical wall located next to the hall with a vent for supplying make-up air, smoke can drive back to the hall as shown clearly in Fig. 2.

Therefore, key equations on calculating the smoke exhaust rate and the required vent area should be reviewed for evaluating wind effect on the performance of static smoke exhaust system. Modified equations with wind effect should be derived carefully. The scenarios at the tall hall concerned with adjacent buildings should be considered. Results on the smoke exhaust rate across the vent with and without wind must be compared.

Immediate Action

All designs of static smoke exhasut systems in big halls with high occupant loading are proposed to carry out similar numercial exercises at their preliminary design stage. Numerical results must be justified by scale model experiments first and then verfied by in-situ hot smoke test.

References

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2. J. Li and W.K. Chow, “Wind effect on smoke exhaust by natural vent”, The 2012 International Conference on "Advances in Wind and Structures (AWAS12)", 26-30 August 2012, Seoul, Korea, Paper presented (2012).
3. H.T. Yeung, “Wind effect on static smoke exhaust of a big cargo hall with adjacent building”, BE-Research project supervised by Professor W.K. Chow, Department of Building Services Engineering, The Hong Kong Polytechnic University, Hong Kong (2013).

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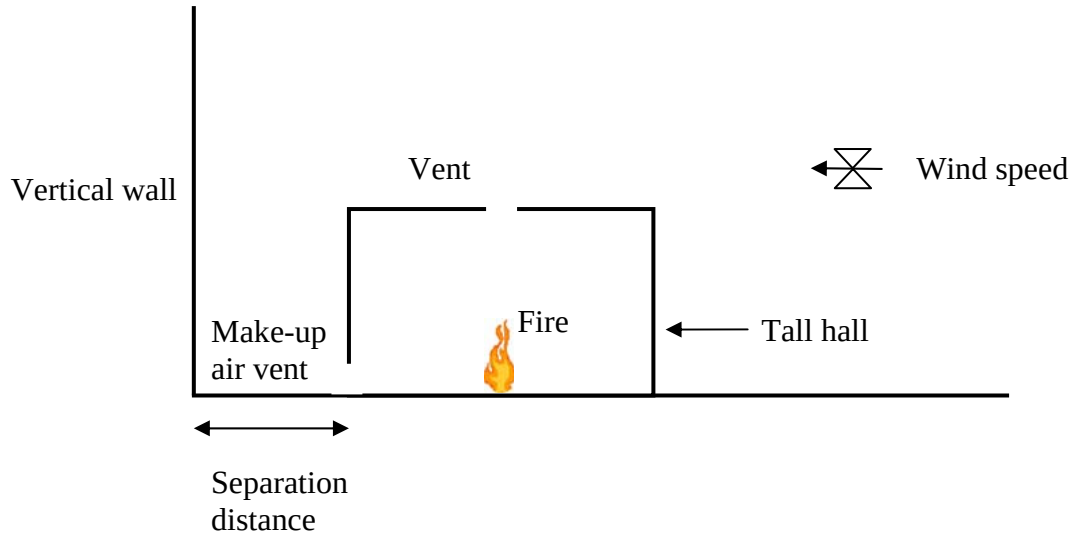

Fig. 1: Scale model experiment

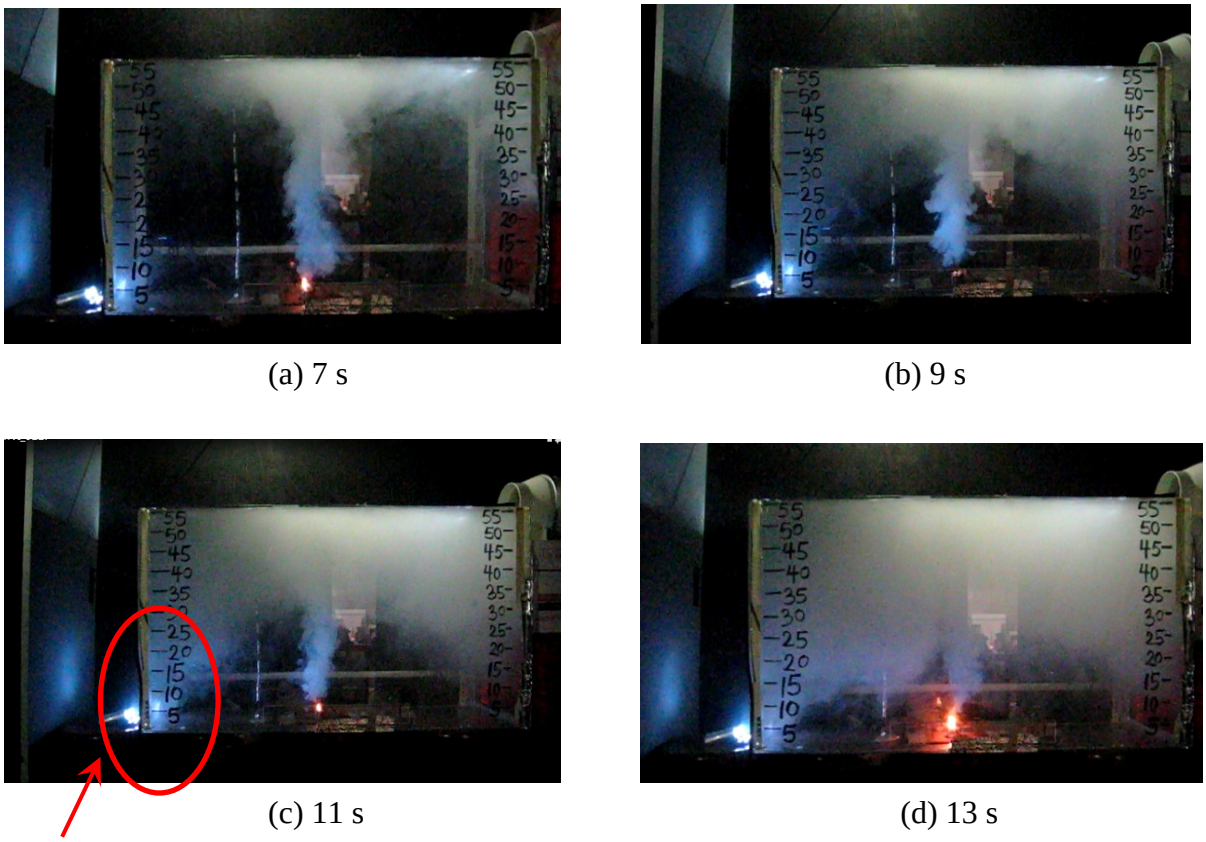

Fig. 2: Adverse effect observed