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Real-time or faster-than-real-time simulation of airflow in buildings

Abstract Real-time flow simulation is crucial for emergency management in buildings, such as fire and accidental or intentional release of chemical/biological agents (contaminants). The simulation results can then be used to impose proper measures to minimize casualties. Computational fluid dynamics (CFD) is accurate, but too time-consuming. Nodal models are fast, but not informative. To obtain a quick and informative solution, this study proposes an intermediate approach between nodal models and CFD by introducing a fast fluid dynamics (FFD) method. This investigation used the FFD methods with and without turbulence treatments to study systematically four basic flows in buildings, and compared the numerical results with the corresponding CFD results and the data from the literature. The results show that, on one hand, the FFD can offer much richer flow information than nodal models, but less accurate results than CFD. On the other hand, the FFD is 50 times faster than the CFD. The results also show that the FFD with the laminar assumption has the best overall performance as regards both accuracy and speed. It is possible to conduct faster-than-real-time flow simulations with detailed flow information by using the FFD method.

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Key words: Fast fluid dynamics; Computational fluid dynamics; Contaminant dispersion; Air distribution; Real time.

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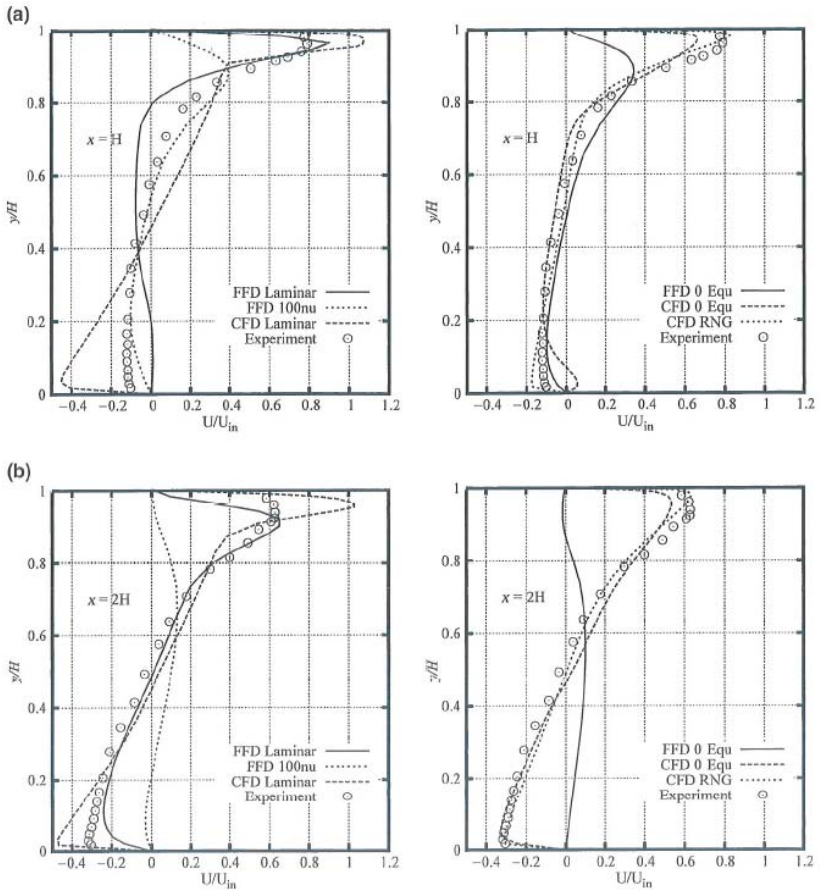

Fig. 4 Comparison of horizontal air velocities predicted by the FFD and CFD with the experimental data. (a) U at $x = H$; (b) U at $x = 2H$