Appendix A: Mesh independence study

Prior to performing the CFD simulations, a grid independence study was conducted over five grid resolutions. Because the heat transfer occurring between the air and the street canyon facets played a key role in this study, particular effort was made to ensure the near-wall mesh quality. In this study, with a fixed grid expansion ratio of 1.1, five types of first layer grid thickness within a range of 0.005 to 0.5 m were selected. The grid discretization followed the AIJ guidelines.

Thus, five mesh types, from coarse to dense, were generated to ensure that the simulation results were sufficiently grid-independent. As shown in Table 1s, when the number of mesh elements was higher than 118126, the airflow velocity, temperature *T*, and PM concentration *C* at the reference location became stable and remained nearly unchanged. Considering computational efficiency, the mesh of the first layer grid thickness $\Delta x = \Delta y = 0.05$ in the canyons and total 118126 mesh elements (Fig. 1s) was used for further simulation.

Appendix B: Model validation

Because of the absence of comprehensive experimental studies recording both street canyon thermal environment data and airflow pattern results, this study implemented two simulation validation tasks to adequately validate the numerical accuracy. First, air vertical velocity profiles were validated against water channel experiments (Baik and Kim, 2002) and simulations ((Baik and Kim, 2002; Cheng *et al*., 2008). The inside temperature along the vertical centerline of the street canyon was then compared with the wind tunnel measurements obtained by Uehara *et al*. (2000) and Tan *et al*. (2015).

For the water channel experiment, a street canyon was constructed using two building models measuring 0.1 m (L) × 0.1 m (W) × 0.4 m (H), which were positioned 0.1 m apart to form an isolated street canyon with h/b = 1. In accordance with the model validation procedure of Baik and Kim (2002), the measured and simulated vertical velocity profiles on the upwind (0.15 b, measured from the windward wall) and downwind (0.15 b, measured from the leeward wall) sides inside the street canyon were compared. Fig. 2s shows the experiment data, numerical results of Cheng (2008) and the present study. The variation trends of the vertical wind profiles on the upwind and downwind sides indicated by the four results were nearly identical. Thus, in the current study, the CFD results were considerably closer to those of the water channel experiment.

The horizontal velocity and temperature distributions within the street canyon were compared with the wind tunnel measurements obtained by Uehara *et al*. (2000). Applying the same aspect ratio of 1, this study compared the numerical results with the wind tunnel data at a Reynolds number of 3500 and a bulk Richardson number of −0.21. Fig. 3s presents a comparison of the normalized temperature and horizontal velocity profiles along the vertical centerline of the street canyon, as predicted by the numerical and experimental methods.

The temperature calculated by the RNG models was lower than that obtained by the wind tunnel measurement and higher than that simulated by Tan *et al*. (2015).

Nevertheless, all the temperature profiles were comparable to each other. The current numerical approach under predicted the near-ground velocity. The value divergence was similar to that reported by Xie *et al*. (2006) and Tan *et al*. (2015). These differences could be attributed to the geometric differences between the current CFD model (a single 2D street canyon) and the wind tunnel model (a 3D layout of building blocks with an extremely short street length). In the current CFD model, the street is assumed to be sufficiently long. By contrast, for the wind tunnel experiment, the relatively short street length assumption caused the airflow separated from the building side walls to affect the flow vortex inside the street substantially. Furthermore, the surface roughness of the solid boundaries in the wind tunnel experiment was unknown, consequently imposing additional uncertainty on our CFD calculation.

As demonstrated in the preceding model validation exercise, the numerical model used in this study is capable of simulating airflow patterns and temperature profiles in street canyons with temperature-varied thermal environments.

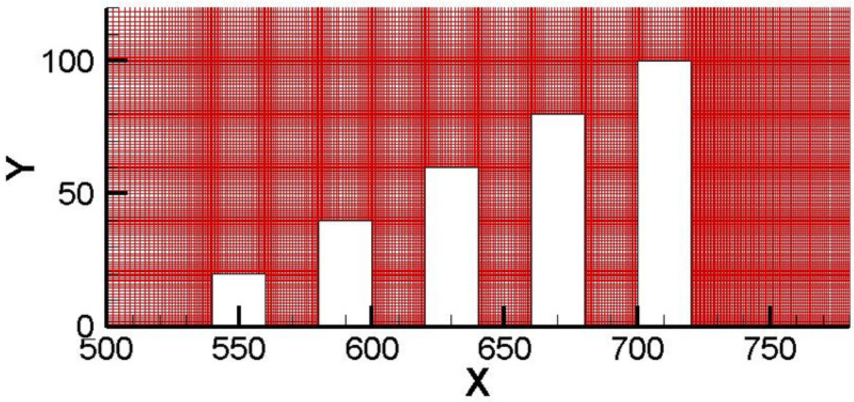
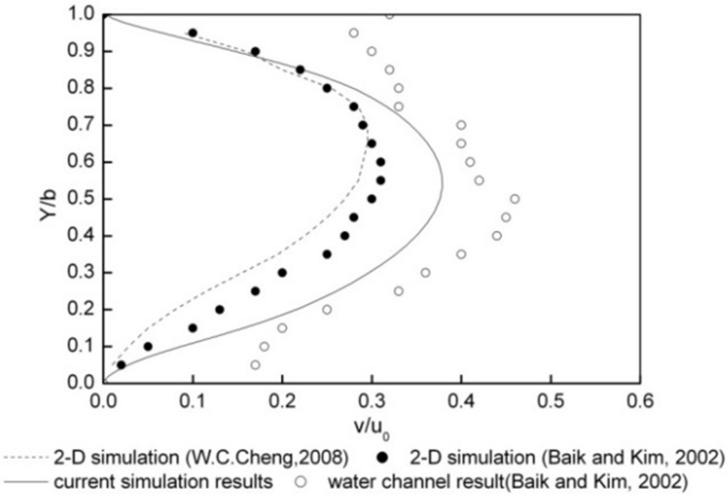
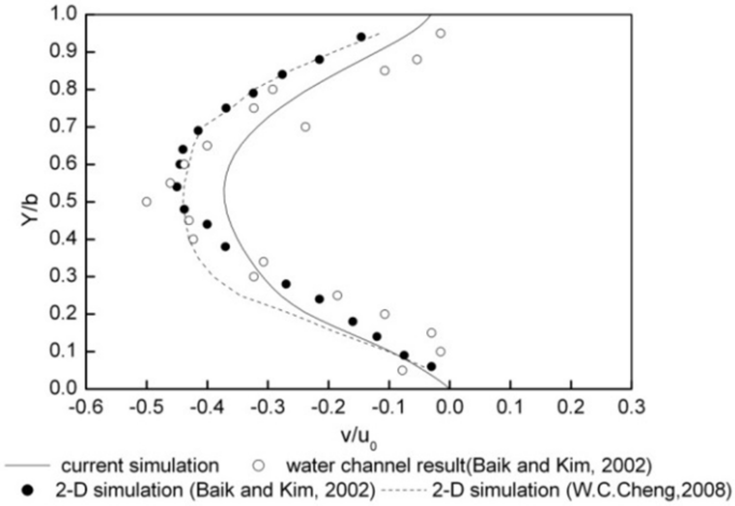


Fig. 1s The mesh adopted in the simulation



(a) Upwind (0.15 b from the windward wall)



(b) Downwind (0.15 b from the leeward wall)

Fig. 2s. Mean vertical velocity at upwind and downwind positions inside street canyon center.

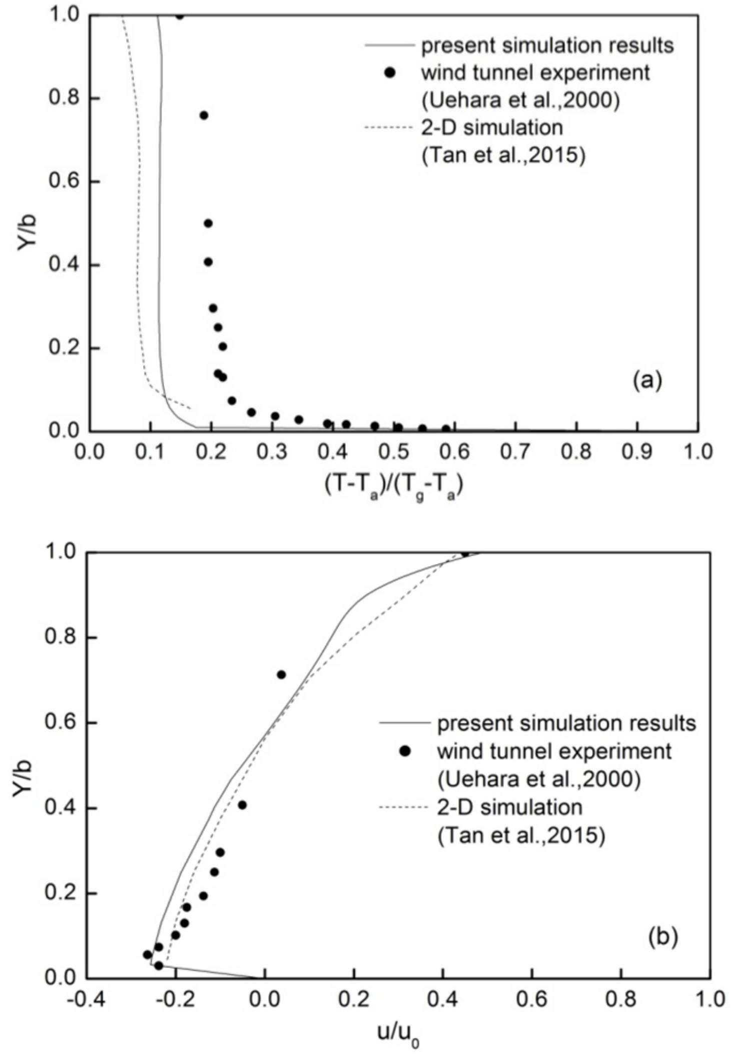


Fig.3s. Vertical profiles of normalized (a) temperature and (b) horizontal velocity along the centerline of the street canyon.

Table 1s Mesh independence study

Elements number	airflow velocity (m/s)	temperature (K)	PM concentration (kg/m^3)
44240	0.3303	300.4998	4.039×10^{-5}
77980	2.1158	299.9996	5.782×10^{-6}
115692	2.0046	299.9997	5.109×10^{-6}
118126	2.0046	299.9997	4.977×10^{-6}
170251	2.0020	299.9997	4.944×10^{-6}