Air Ventilation Assessment Study
Sun Yuen Long Centre Site

Environmental Central Facility/Institute for the Environment

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1. INTRODUCTION

1.1 Background and Objectives

1.1.1 One of the general common concerns about Hong Kong's wind environment is the low level of wind experienced by pedestrians, this is closely related to the low level of permeability or porosity in the urban fabric. The problem is exacerbated by compact building masses, uniform building heights, large podium structures with limited or no opening at pedestrian level, narrow spaces between buildings, streets not aligning in the directions of the prevailing wind, lack of greenery, shading and landscape, etc. Understanding the urban fabric problems would provide insights into the effective design solutions for improving the wind environment.

1.1.2 The objective of this study is to investigate an air ventilation assessment of the design scheme by comparing the wind environment before and after the proposed construction as recommended in the AVA Study. This serves as an example to provide a scientific and objective basis for identifying climatically sensitive areas and assessing the impacts of major developments and planning proposals on the local wind environment.

1.1.3 AVA methodology and guidance for applying AVA to major Government project were outlined in a Technical Circular jointly issued by the Housing, Planning and Lands Bureau (HPLB) and the Environment, Transport and Works Bureau (ETWB). Moreover, design guidelines for improving air ventilation have also been incorporated into the Hong Kong Planning Standards and Guidelines (HKPSG).

1.2 Site Environs

1.2.1 The proposed development site A is located at the Yuen Long Station and the proposed development site B is located at the south of the Sun Yuen Long Centre bounded by Long Yat Road. To the south of the proposed development B is Castle Peak Road – Yuen Long. Figure 1 and Figure 2 shows the location of the subject sites and their environs.

1.2.2 To the immediate south of the proposed site A and to the north of the proposed site B is Sun Yuen Long Centre with 5 blocks above it.

1.2.3 To the southeast of the proposed site is YoHo Town Arcade with Phases I, II and III.

1.2.4 The topography is relatively flat on site and in the immediate surroundings.

1.3 General Features Affecting the Wind Environment

1.3.1 The air ventilation assessment would generally focus on the summer season. In summer season, the temperature is typically higher than other seasons. According to the HKO temperature records in 2004, 2005 and 2006 (refer to Table 1), the temperature in June, July and August are higher than in other months. The monthly mean in summer is 21% higher when compared with the annual mean. Therefore, the air ventilation is a concern for pedestrian comfort primarily in the summer season.

1.3.2 In summer, Hong Kong typically experiences a southerly wind. Figure 3 shows the wind rose at the proposed development sites in summer in 2004 calculated by the MM5/CALMET system; for the details, please refer to Yim et al (2007) and Yim et al. (2009). Due to 41% of the wind occurring from the south-eastern sector, a south-easterly wind is provided as a boundary condition in the CFD simulation.

1.3.3 The closely packed tall buildings of proposed Yoho town phases I II and III are located immediately upstream in the south-eastern directions and reduce the wind availability. Weaker southerly wind is likely to be experienced.

1.3.4 A proposed residential and commercial development site located to the east of the proposed development site would further reduce the wind availability in the Sun Yuen Long Centre.

2. DESIGN SCHEME UNDER DETAILED STUDY

2.1 Design Scheme

2.1.1 A design scheme case and one reference case are the subject of Detailed Study. They are:

(a) Revised Scheme (Figure 5): The maximum residential and commercial GFA are 136,362 m2 and total plan ratio is 3.93; 7 blocks with 44 floors and 2-floor podiums are proposed to be built.

(b) Reference case – this is the benchmark to quantify the influence of the revised scheme to the wind environment surrounding the proposed development site.

3. ASSESSMENT APPROACH

3.1 General

3.1.1 A Computational Fluid Dynamics model (CFD), Fluent v6.3, is utilized as the assessment tool to investigate the influence of the proposed development on the air ventilation. The validation of the model is described in detail in Yim et al., (2009).

3.1.2 The wind profile is provided by a MM5/CALMET system; for details, please refer to Yim et al (2007) and Yim et al. (2009). Figure 4 shows the vertical wind profile for the boundary condition in the CFD simulation.

3.1.3 Further details of assessment approach of Site Wind Availability Data Study and Detailed Study are described below.

4. SUMMARY OF RESULTS AND DISCUSSION

4.1 Figure 6 shows wind speed contour at the pedestrian level (2m above ground) of the area surrounding the Sun Yuen Long Centre in (a) reference case and (b) revised scheme. As shown in the figure, the wind speed in street A is reduced significantly.

4.2 The revised scheme suggests designing a ventilation corridor under the podium at the proposed development site B. However this will not significantly mitigate the wind speed reduction in the street A. The wind speed ratio reduction in this case is 26.7% (please Table 2) when compared with the reference case.

4.3 Figure 7 shows wind vector at the pedestrian level (2m above ground) of the area surrounding the Sun Yuen Long Centre in (a) reference case and (b) revised scheme. The figures show that westerly wind is experienced in street A. However, the magnitude of the wind is reduced in the revised scheme, especially at the south end of the street A.

4.4 Figure 8 shows the wind speed contour at the pedestrian level (2m above podium) of Sun Yuen Long Centre in (a) reference case and (b) revised scheme. These figures indicate pedestrian comfort on the podium of the Sun Yuen Long Centre. The figures show that the wind speed is reduced significantly in the revised scheme.

4.5 As shown in Table 2, the average percentage reduction of wind speed ratio at the pedestrian level (2m above podium) of the Sun Yuen Long Centre is 50% compared with the reference case.

4.6 Figure 9 shows the wind vector at the pedestrian level (2m above podium) of the Sun Yuen Long Centre in (a) reference case and (b) revised scheme. The figures show the wind vector becoming weakened towards the west of the podium in the revised scheme. The westerly wind at the east of the podium is changed to northerly wind.

5. Future Prospect

The results of this study reveal that the revised scheme causes a significant wind speed reduction in the environment surrounding the Sun Yuen Long Centre. This initial analysis studied the wind speed reduction in two regions – street A (please refer to Figure 10) and the podium of the Sun Yuen Long Centre (please refer to Figure 1). It found that, when compared with a reference case (current situation), the wind speed may be reduced 26% and 46% in street A and the podium of the Sun Yuen Long Centre respectively. Such a large percentage wind speed reduction may influence the air pollutant dispersion in the environment surrounding the Sun Yuen Long Centre. Thus, the future prospect is to study the retention time of pollutants in both the reference case and the revised scheme. The details of retention time are fully explained in Yim et al. (2009).

6. Disclaimer

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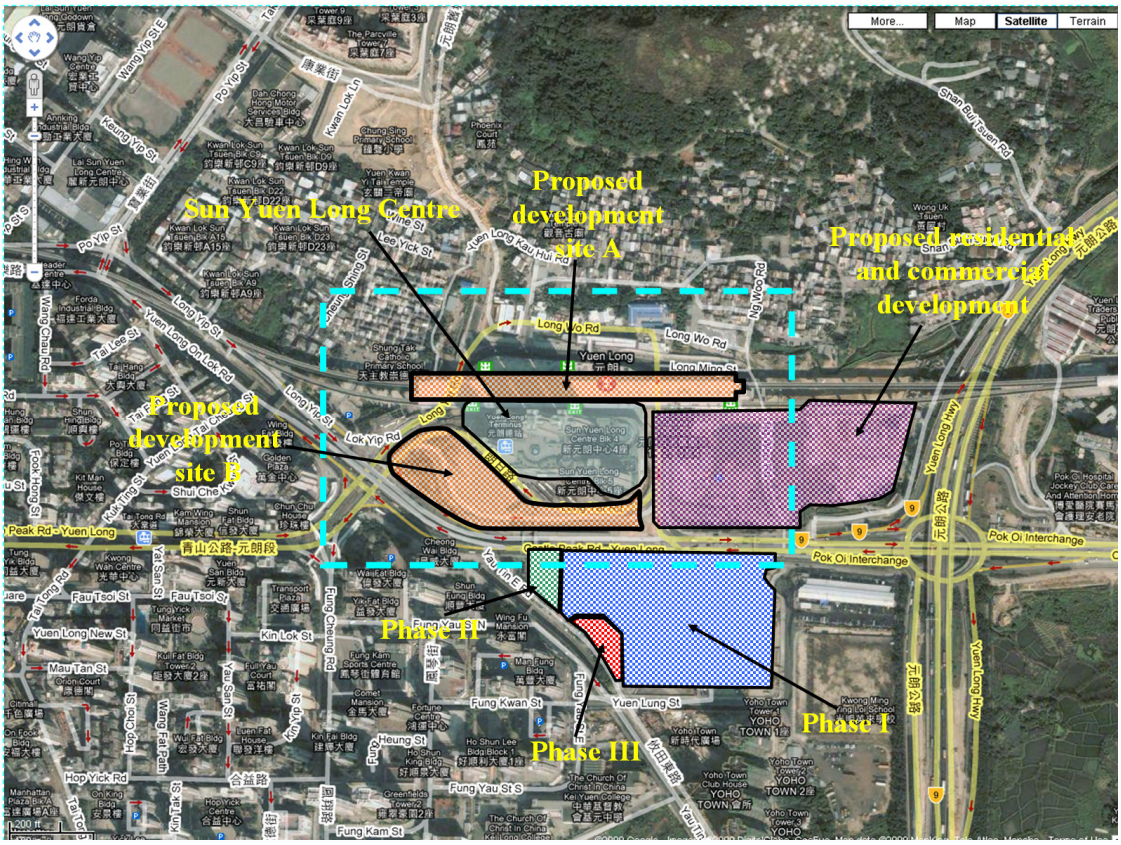

Figure 1 Proposed development site and the surrounding environment.

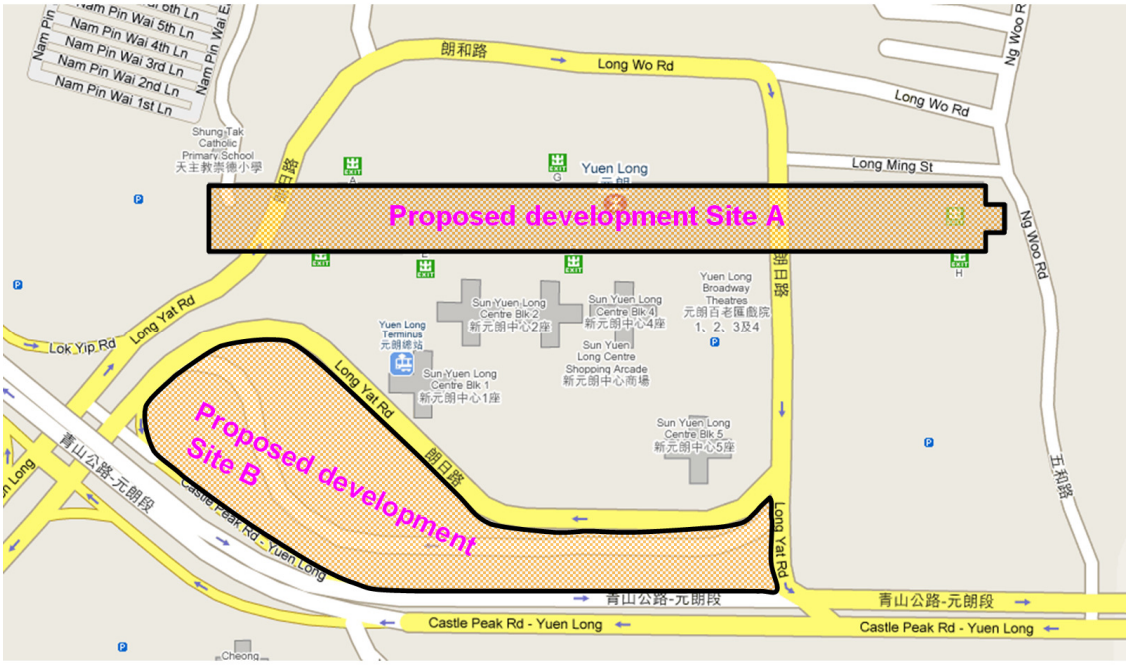

Figure 2 Proposed development site and the surrounding environment (zoomed).

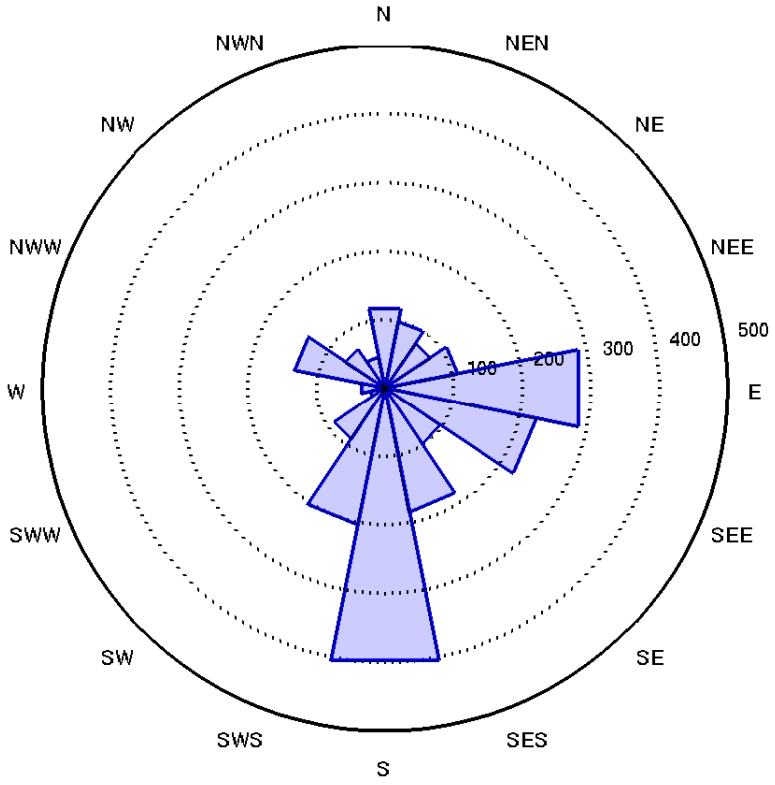

Figure 3 Wind rose of the proposed development site in summer (Jun-Aug) in 2004.

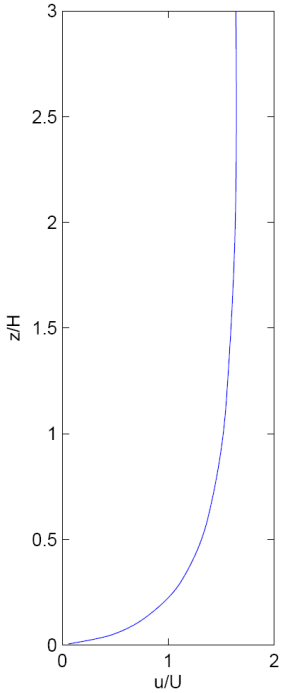

Figure 4 Vertical wind profile of the CFD model simulation.

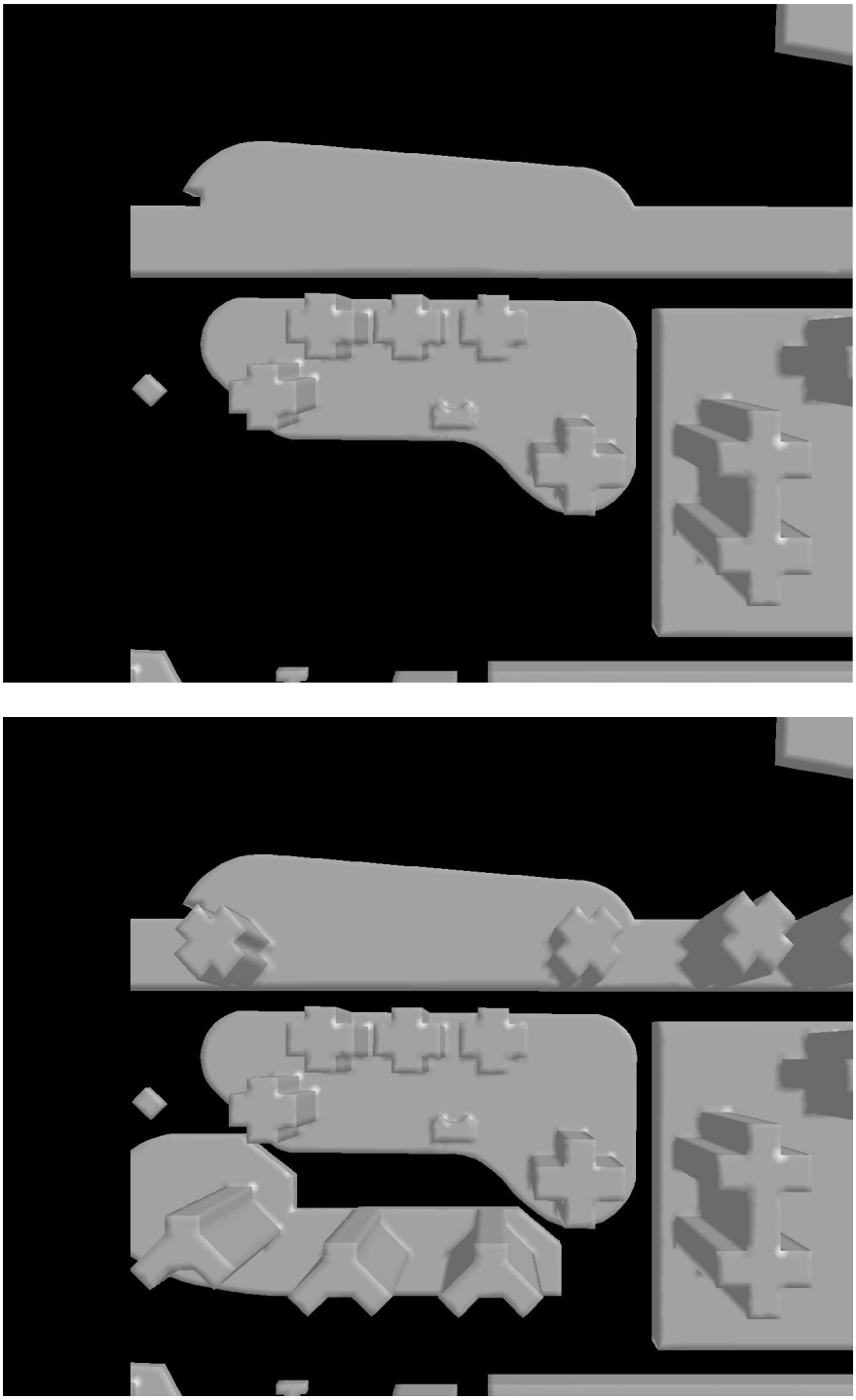

Figure 5 Building geometry of surrounding area of Sun Yuen Long Centre in (a) reference case and (b) revised scheme.

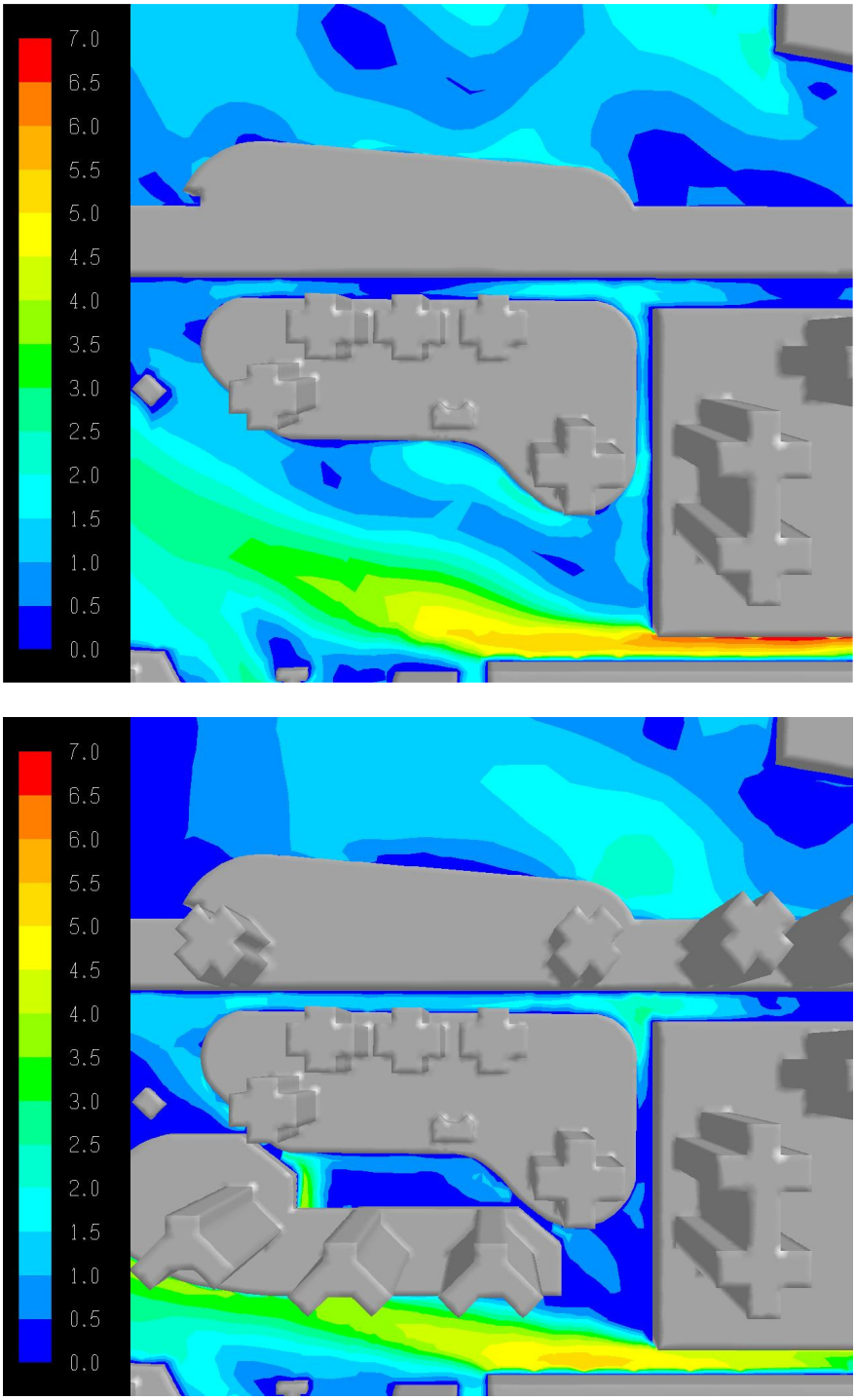

Figure 6 Wind speed contours at the pedestrian level (2m above ground) of the area surrounding the Sun Yuen Long Centre in (a) reference case and (b) revised scheme.

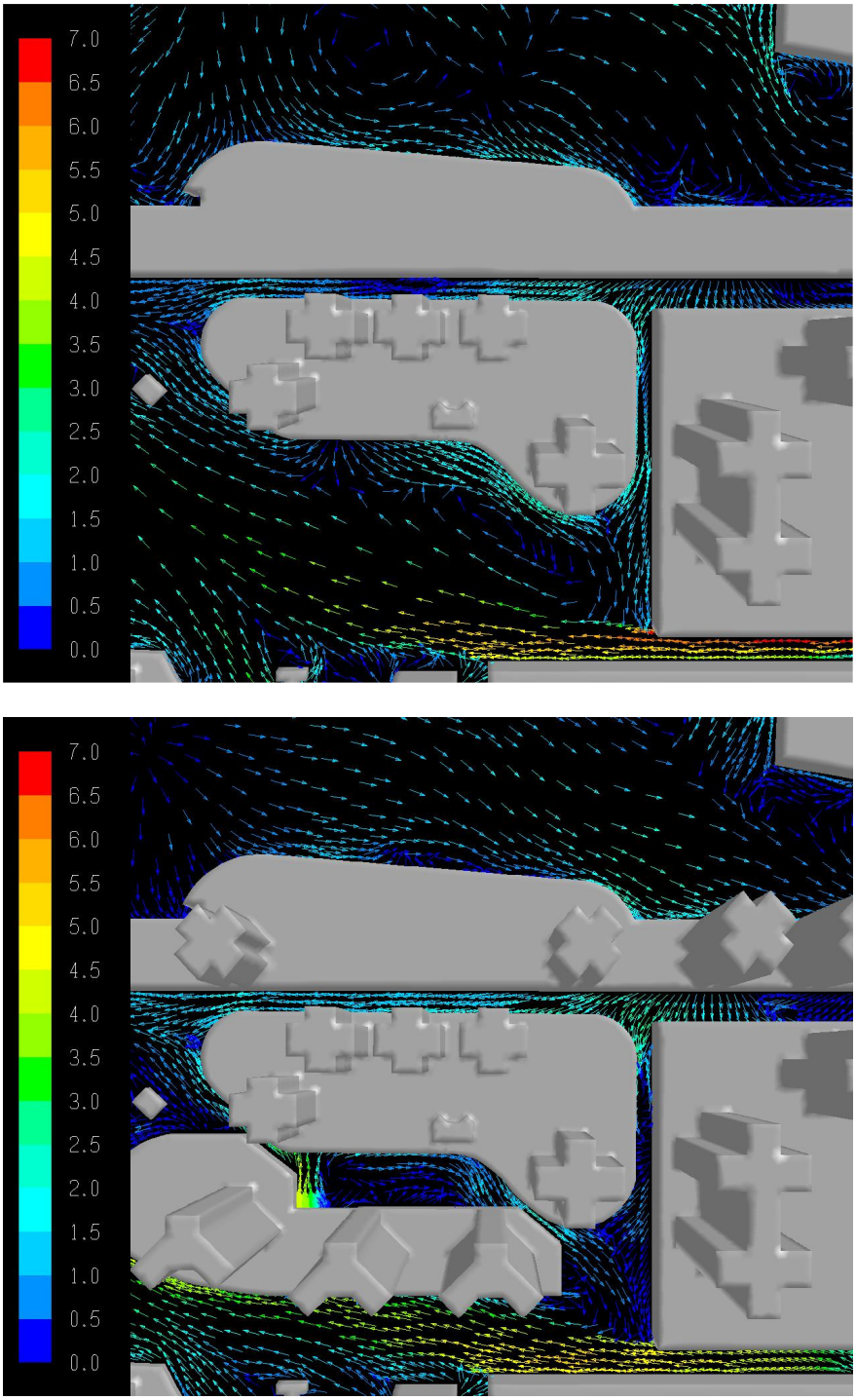

Figure 7 Wind vectors at the pedestrian level (2m above ground) of the area surrounding the Sun Yuen Long Centre in (a) reference case and (b) revised scheme.

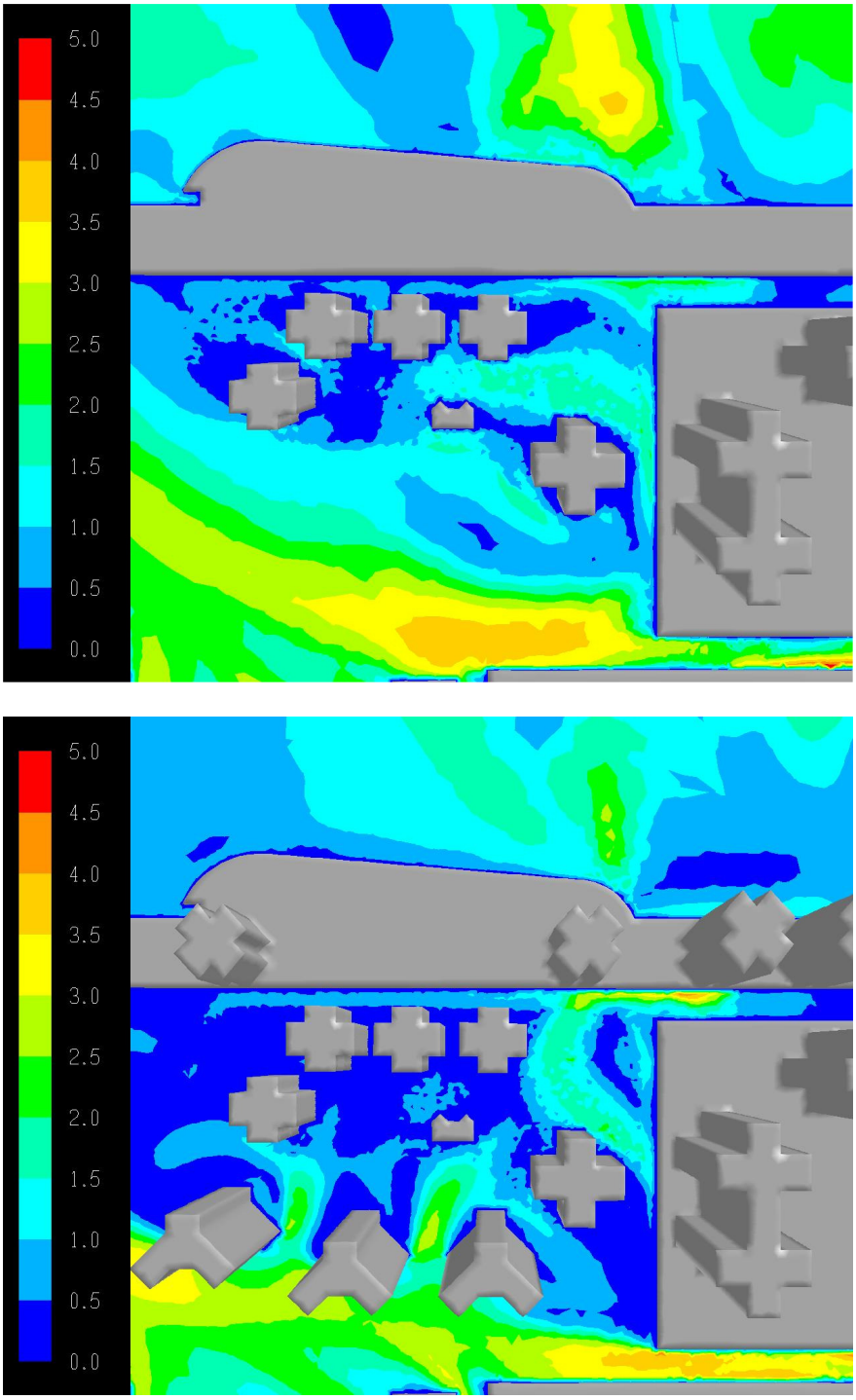

Figure 8 Wind speed contours at the pedestrian level (2m above podium) of the Sun Yuen Long Centre in (a) reference case and (b) revised scheme.

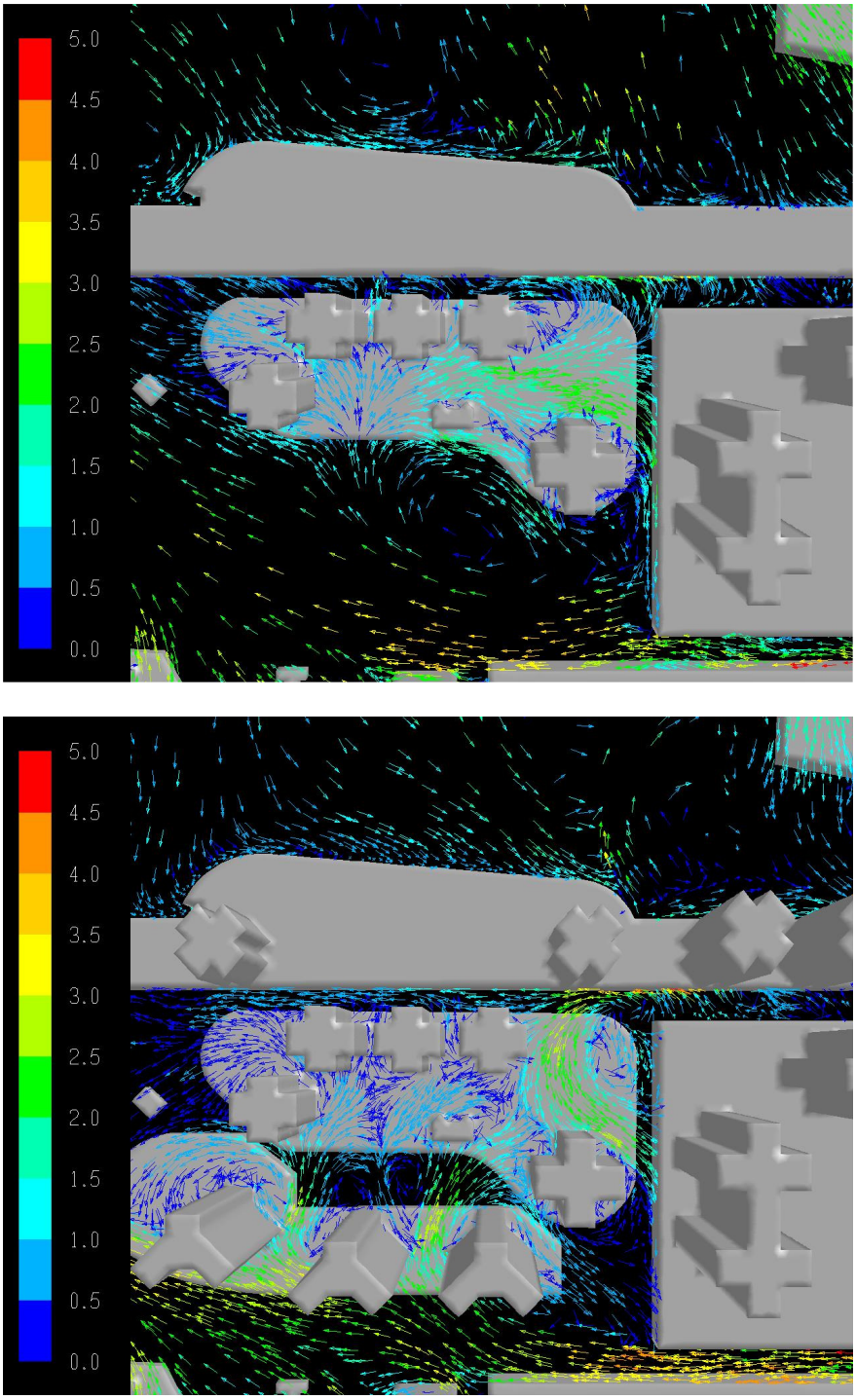

Figure 9 Wind vectors at the pedestrian level (2m above podium) of the Sun Yuen Long Centre in (a) reference case and (b) revised scheme.

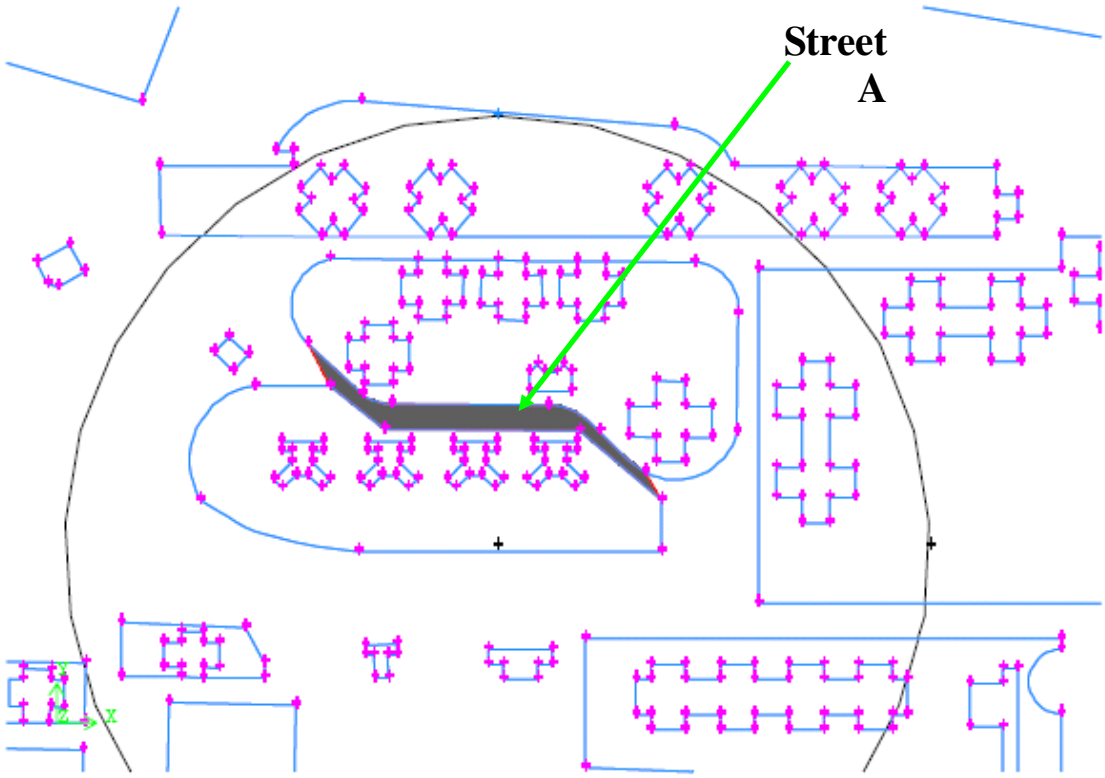

Figure 10 Location of Street A represented by grey colour.

	2006			2005			2004		
Month	Mean Daily Maximum (deg. C)	Mean (deg. C)	Mean Daily Minimum (deg. C)	Mean Daily Maximum (deg. C)	Mean (deg. C)	Mean Daily Minimum (deg. C)	Mean Daily Maximum (deg. C)	Mean (deg. C)	Mean Daily Minimum (deg. C)
1	18.4	16.4	14.7	17.9	15.9	14.2	17.5	15.8	14.2
2	20.1	17.7	15.8	18.3	16.5	14.8	19.4	17.2	15.4
3	20.5	18.5	26.6	19.7	17.4	15.2	21.1	19.1	17.7
4	26.3	23.9	22.0	25.4	23.1	21.3	25.3	22.9	21.2
5	28	25.8	24.0	28.8	27.0	25.3	28.6	26.3	24.5
6	**29.9**	**28.0**	**26.3**	**29.7**	**27.8**	**25.9**	**30.8**	**28.6**	**26.8**
7	**31.2**	**29.0**	**27.0**	**31.8**	**29.1**	**26.9**	**30.5**	**28.4**	**26.6**
8	**30.8**	**28.3**	**26.5**	**30.2**	**28.0**	**26.3**	**30.7**	**28.4**	**26.5**
9	29.1	26.6	24.8	30.4	28.2	26.5	29.9	27.6	25.9
10	29.0	26.4	24.7	28.3	26.2	24.4	27.5	24.9	22.9
11	25.5	23.3	21.6	25.0	23.0	21.4	24.5	22.7	21.1
12	20.4	18.2	16.1	19.1	17.0	15.0	21.1	19.1	17.2
Average	25.8	23.5	21.7	25.4	23.3	21.4	25.6	23.4	21.7
Normal	25.7	23.0	20.9	25.7	23.0	20.9	25.7	23.0	20.9

Table 1 Monthly temperature of HK in 2004, 2005 and 2006. Red colour represents the summer season.

Case	Street A (2m above ground)	Sun Yuen Long Centre (2m above the podium)
Reference	0.15	0.04
Revised	0.11	0.02
Percentage difference with Reference case	-26.7%	-50.0%

Table 2 Wind speed ratio at pedestrian level (2m above ground) of Street A and podium of the Sun Yuen Long Centre.

Reference

Fluent, User manual of Fluent version 6.3, ANSYS, Inc.

Gambit, User manual of Gambit, ANSYS, Inc.

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Yim, S. H. L., J. C. H. Fung, A. K. H. Lau, and S. C. Kot (2007), Developing a high-resolution wind map for a complex terrain with a coupled MM5/CALMET system. J. Geophys. Res., VOL. 112, D05106, doi:10.1029/2006JD007752, 2007.

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