Hong Kong Housing Authority

Redevelopment of So Uk Estate Phase 1 & 2

Air Ventilation Assessment (AVA) Expert Evaluation

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Contents

Executive Summary

Two scenarios were selected for the AVA Expert Evaluation: 1) Existing Site Condition and 2) Proposed Design Scheme.

The wind majorly comes from NE, E, SE and SW. Therefore, the wind performances under both existing site condition and proposed design scheme at pedestrian level are evaluated based on these wind directions.

Existing Site Condition

The building blocks are arranged closely together, this worsens the air ventilation of the open space areas among the blocks. Meanwhile, the air permeability of the site is reduced as there is no apparent wind corridor.

- Along the north boundary, the four linear blocks are aligned closely together resulting in "wall effect". Consequently the wind from NE is blocked.
- The easterly wind flow would also be obstructed by the trident blocks at the centre of the site and the two linear blocks along the southeast boundary
- Under SE wind condition, the wind flow would be deflected by the linear blocks along the southeast boundary. As a consequence, the leeward blocks are in wind shadow.
- Under SW wind condition, the wind flow approaching the Development is sheltered by the high-rise developments on the windward side.

In summary, the existing site layout creates heavy wind obstruction and thus adversely affects the air ventilation of the site as well as its immediate surroundings.

Proposed Design Scheme

The blocks are located such that wind could penetrate through the building separations. Long and connected buildings are replaced by a mixture of less-bulky buildings and open spaces. As a result, the permeability of the site could be increased from a general perspective.

Under NE wind condition

The increased air flow could help to improve the wind condition of the Po On Road as well as its surrounding areas under NE wind condition.

Under E wind condition

Voids are designed at the ground level of building blocks 1 to 6 which enhances the wind permeability. Under the E wind condition, the space between Blocks 1 to 3 and Blocks 4 to 6 can allow more wind to penetrate the site.

Under SE wind condition

Block 10 to Block 12 are aligned from south-east to north-west to create a breezeway for the prevailing SE wind. This wind corridor can help to improve the wind condition at surrounding area west to the site.

Under SW wind condition

The building gap between Block 10 and Block 11 is connected to Cheung Wah Street. Therefore wind coming from SW can pass through this wind corridor.

The ground level void of Block 1 and 4 could further enhance the wind performance by allowing more wind to penetrate. No adverse effect has been found on Low-rise residential development at north of Ching Cheung Road.

The building gap between Block 11 and Block 12 serves as major wind corridor for air penetration. The wind corridors can help to improve the wind condition at surrounding area north to the site.

Wind responsive design

Some wind-responsive designs were incorporated into the proposed scheme to improve the ventilation performance of the surrounding area:

- Widened wind corridors at ground level due to ground floor voids in Phase 1
- Ground floor ventilation corridors and ventilation bays at podium level
- Height variation along the prevailing wind direction to help downward wind flow and avoid air stagnation

1 Introduction

1.1 Project Background

Ove Arup and Partners Hong Kong Limited (Arup) was commissioned by Hong Kong Housing Authority (HKHA) to conduct environmental design studies for the Redevelopment of So Uk Estate Phase 1 & 2 (the Development). One of the tasks is to undertake an expert evaluation study on Air Ventilation Assessment (AVA) for the Development.

1.2 Study Objective

The objective of this study is to evaluate the wind performance of the Development using the methodology of Air Ventilation Assessment, based on the "Housing Planning and Lands Bureau – Technical Circular No. 1/06, Environment, Transport and Works Bureau – Technical Circular No. 1/06" issued on 19th July 2006 (the Technical Circular) and "Technical Guide for Air Ventilation Assessment for Development in Hong Kong – Annex A" (the Technical Guide). This file note presents the findings for the study of Stage 1 – Expert Evaluation.

1.3 Study Tasks

The major tasks of this study is to carry out an expert evaluation on the characteristics of the site wind availability data of the development area and assessment of the wind performance under existing development situation and the proposed building design option in a qualitative way. The expert evaluation will cover the following tasks:

- Identify good design features
- Identify obvious problem areas and propose some mitigation measures
- Define methodologies of the Initial Study

2 Wind condition

To investigate the wind performance of the development site, the characteristic of the natural wind availability of the site is essential to the wind environment study. As stipulated in the Technical Guide, the site wind availability (V∞) would be presented by using appropriate mathematical models (e.g. MM5 simulation).

Planning Department (PlanD) has set up a set of wind availability data of the Territory for AVA study, which could be downloaded at Planning Department Website (http://www.pland.gov.hk/misc/MM5/main.htm). The wind availability data obtained from the MM5 simulation is utilised for the Expert Evaluation, as shown in the following figure.

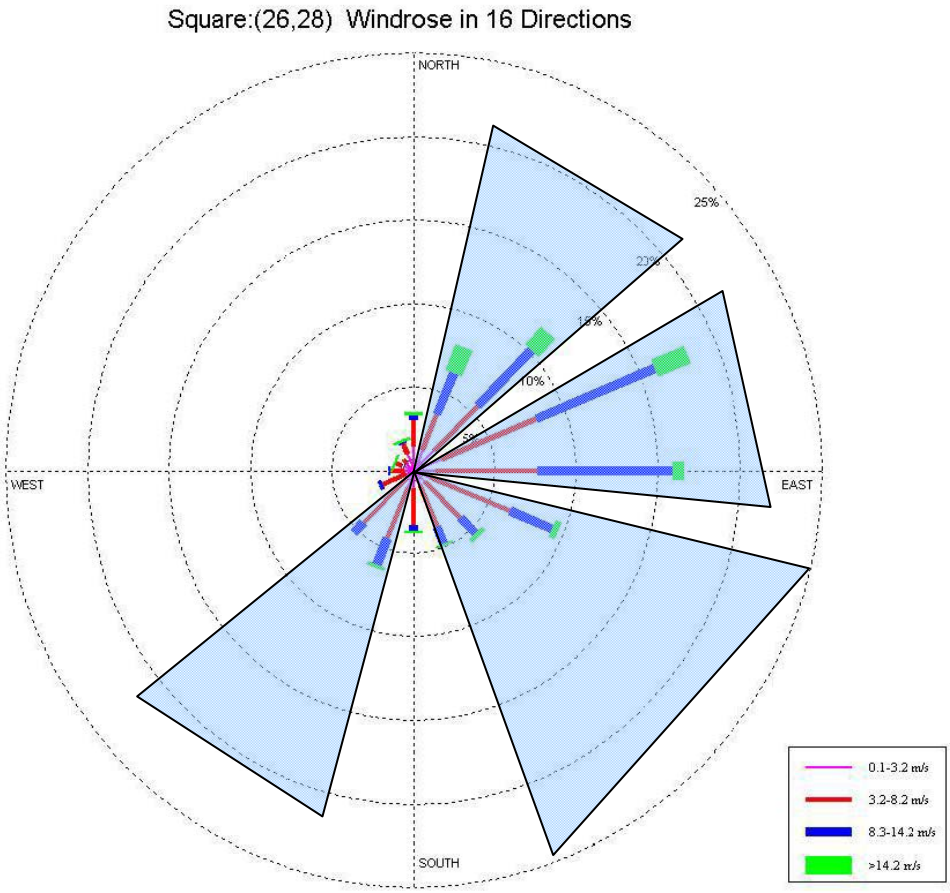

Figure 1 Wind rose for the Redevelopment of So Uk Estate Phase 1 & 2 obtained from MM5 database

The following table shows the probability of 16 wind directions.

Wind Direction	Percentage of Occurrence (%)	Wind Direction	Percentage of Occurrence (%)
North (N)	3.5	South (S)	3.7
North-northeast (NNE)	7.9	South-southwest (SSW)	6.2
Northeast (NE)	11.5	Southwest (SW)	5.2
East-northeast (ENE)	18.0	West-southwest (WSW)	2.3
East (E)	16.4	West (W)	1.6
East-southeast (ESE)	9.4	West-northwest (WNW)	1.3
Southeast (SE)	5.5	Northwest (NW)	0.9
South-southeast (SSE)	4.8	North-northwest (NNW)	2.0

Table 1 Probability of 16 wind directions

For ease of discussion, the dominant winds are grouped as shown in Figure 1 to account for the features of major wind directions. Without loss of generality, the neighbouring winds are represented as a single direction to illustrate the effect of the similar winds. The chosen four groups are NE, E, SE and SW winds as shown in Figure 3 on page 5.

3 Site Characteristics

The Development is located on the north of Cheung Sha Wan Area with a site area is around 7.7ha. The built environment surrounding the site is of typical high-density urban context of Hong Kong. To the north of the site is the Eagle's Nest (Tsim Shan) of ~300m high. The figure below shows the aerial photo of the Development.

Figure 2 Aerial photo of the Redevelopment of So Uk Estate Phase 1 & 2

The key features of the site characteristics and surrounding building environment are:

- There is gradient difference across the site, changing from around +10mPD at the south to around +39 mPD at the north
- Hilly topography to the north of the site
- Regular street pattern
- High building density
- Some high-rises located south-east and south-west to the site

4 Expert evaluation

4.1 Study Scenarios

Two scenarios were selected for the AVA Expert Evaluation: 1) Existing Site Condition and 2) Proposed Design Scheme.

4.1.1 Existing Site Condition

The existing So Uk Estate comprises 15 nos. mid-rise domestic blocks. The built form of the blocks is either long and linear or trident. The blocks are densely built, resulting in a relatively congested built environment.

4.1.2 Proposed Design Scheme

This scheme comprises:

(a) 14 nos. of non-standard blocks ranging from 6 to 41 storeys;

(b) A one storey covered carpark integrated with refuse collection point and a 2-storey carpark podium;

(c) Commercial and social welfare facilities are provided at street level and building podium along Po On Street and Cheung Fat Street;

4.2 Approaching Wind Conditions

As described in Section 2, the wind majorly comes from NE, E, SE and SW. Therefore, the wind performances under both existing site condition and proposed design scheme at pedestrian level are evaluated based on these wind directions.

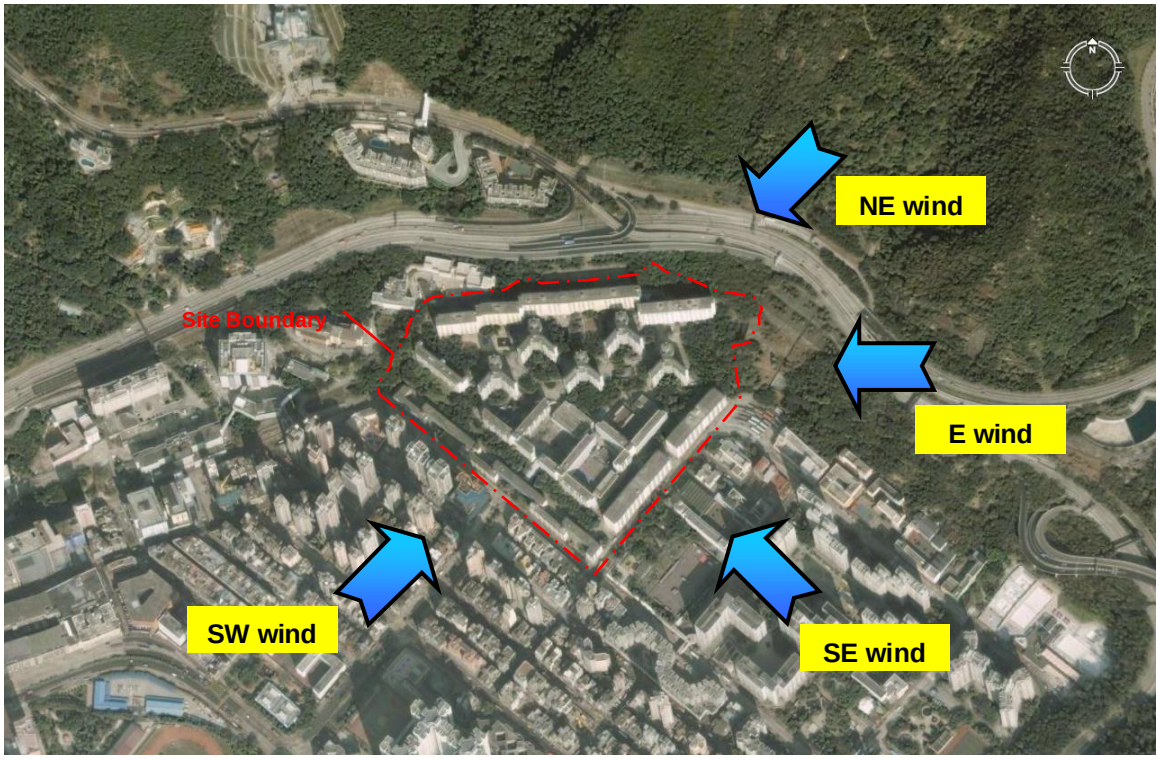

Figure 3 The eight most frequent approaching wind directions for the Development

Figure 3 shows the most frequent approaching wind directions for the Development. The prevailing wind is from the NE quadrant and approaches the site down the hill.

For more than half of the time in a year, the Development is at a relative windward position. In other words, it would have certain impact on the air ventilation of it immediate surroundings.

4.3 Qualitative Assessment of the Ventilation Performance of the Existing Site Condition

Figure 4 illustrates the existing site layout of the Development. It could be observed that the building blocks are arranged closely together. This would have adverse impact on air ventilation of the open space areas in between the blocks as these areas would be in wind shadow. Meanwhile, the air permeability of the site is reduced as there is no apparent wind corridor.

Figure 4 Existing site condition of So Uk Estate

The findings of the qualitative assessment of the air ventilation performance of the Existing Site Condition are summarized below.

Along the north boundary, the four linear blocks are aligned closely together resulting in "wall effect". Consequently the wind from NE is blocked (Figure 5).

Similarly, the easterly wind flow would also be obstructed by the trident blocks at the centre of the site and the two linear blocks along the southeast boundary (Figure 6).

Under SE wind condition, the wind flow would be deflected by the linear blocks along the southeast boundary. As a consequence, the leeward blocks are in wind shadow (Figure 7).

Under SW wind condition, the wind flow approaching the Development is sheltered by the high-rise developments on the windward side. The SW wind approaching the site mainly comes from the wind channel along Hing Wah Street. Notwithstanding, the long liner block along the southwest boundary would block this wind flow to the leeward buildings of the site (Figure 8).

In summary, the existing site layout creates heavy wind obstruction and thus adversely affects the air ventilation of the site as well as its immediate surroundings.

Figure 5 Wind sheltering under NE wind condition for the Existing Site Condition

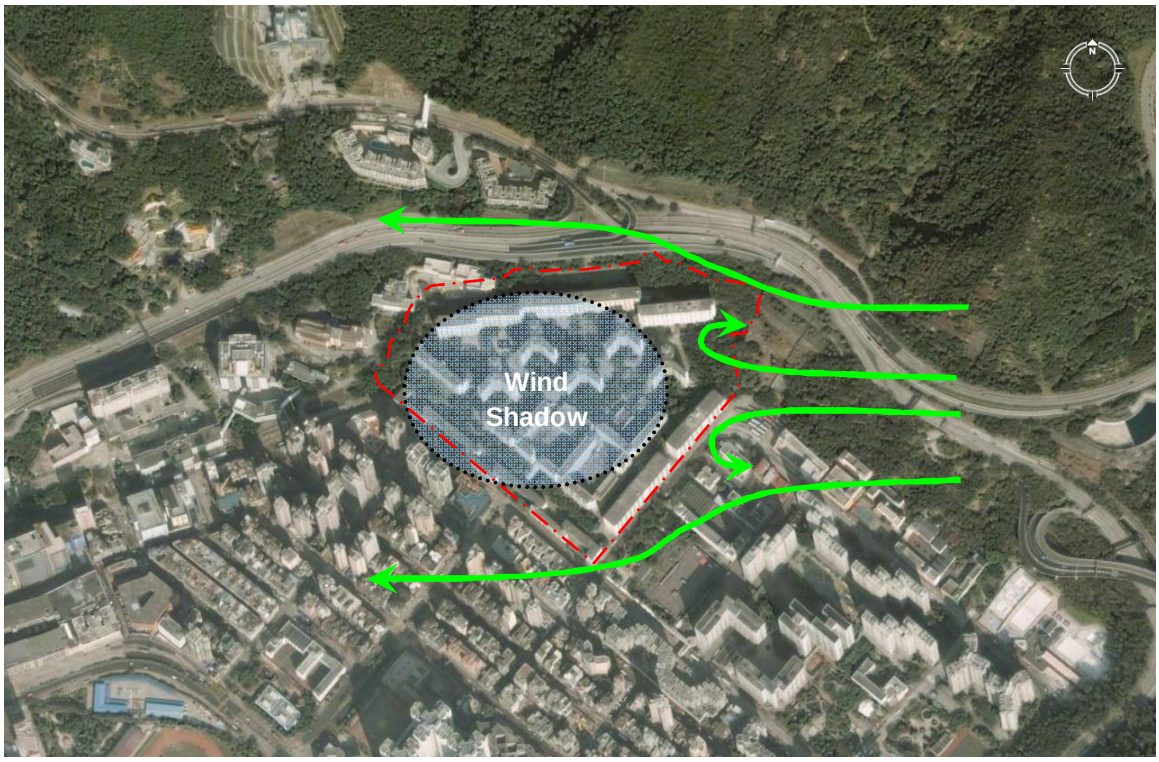

Figure 6 Wind sheltering under E wind condition for the Existing Site Condition

Figure 7 Wind sheltering under SE wind condition for the Existing Site Condition

Figure 8 Wind sheltering under SW wind condition for the Existing Site Condition

4.4 Qualitative Assessment of the Ventilation Performance of the Proposed Design Scheme

Figure 9 illustrates the existing site layout of the Development. It could be observed that the space is more "open" as compared to the existing layout.

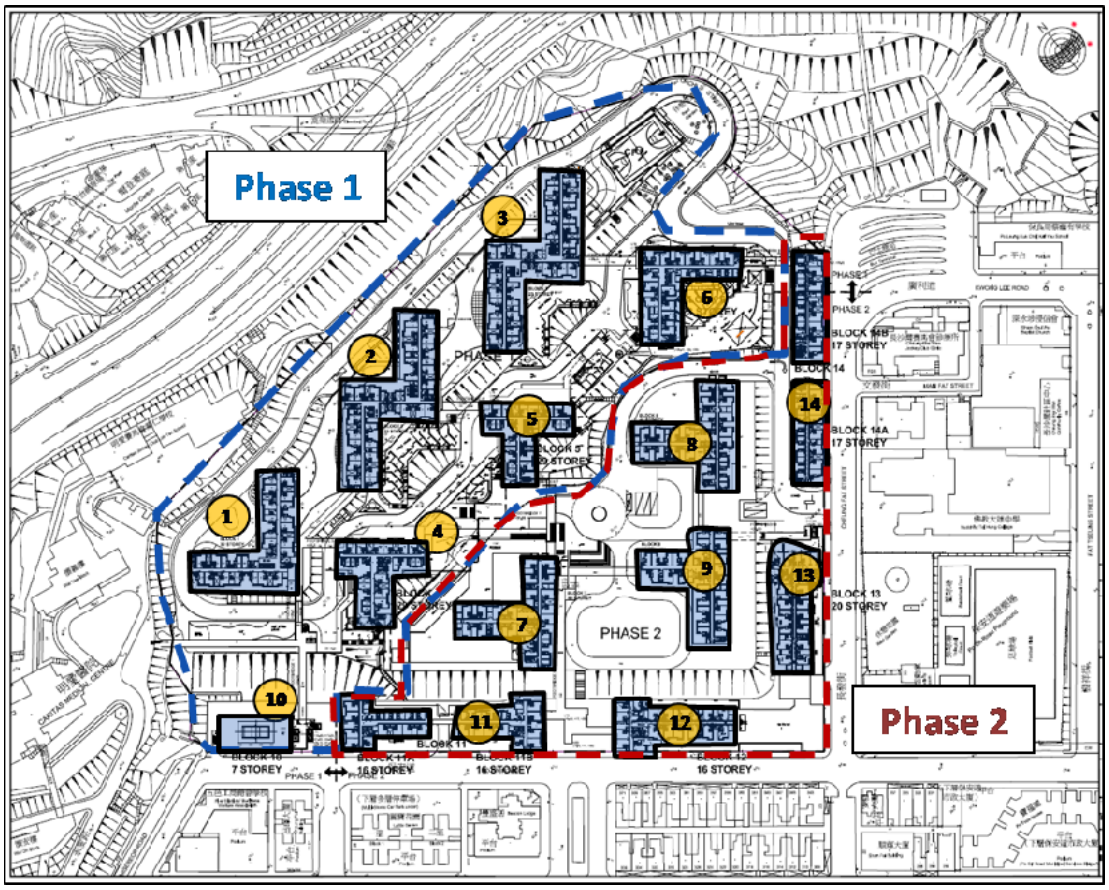

Figure 9 Proposed Design Scheme of the Redevelopment of So UK Estate Phase 1 & 2

The findings of the qualitative assessment of the air ventilation performance of the Proposed Design Scheme are summarized below.

4.4.1 Good Design Features

The blocks are located such that wind could penetrate through the building separations. Long, connected buildings are replaced by a mixture of less-bulky buildings and open spaces. As a result, the permeability of the site could be increased from a general perspective.

4.4.2 Wind Corridors

As stated in the "Urban Design Guidelines" developed by Planning Department, "An array of main streets/wide main avenues should be aligned in parallel, or up to 30 degree to the prevailing wind direction, in order to maximise the penetration of prevailing wind through the district" Therefore the orientation of building Block 1 to Block 3 is a good example of allowing more wind to penetrate the site, which may improve the wind condition of the current development site. Meanwhile the increased air flow could help to improve the wind condition of the Po On Road as well as its surrounding areas under NE wind condition (Figure 10).

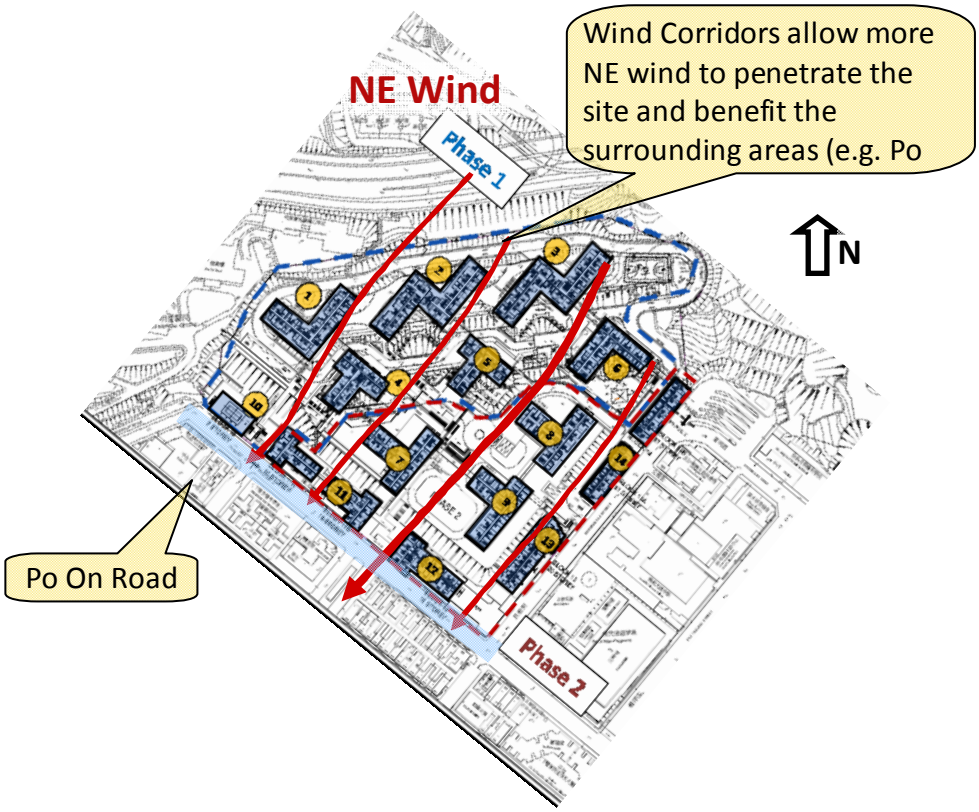

Figure 10 Wind corridors for NE wind to penetrate the site

Similarly, Block 10 to Block 12 are aligned from south-east to north-west to create a breezeway for the prevailing SE wind (Figure 11). This wind corridor can help to improve the wind condition at surrounding area west to the site.

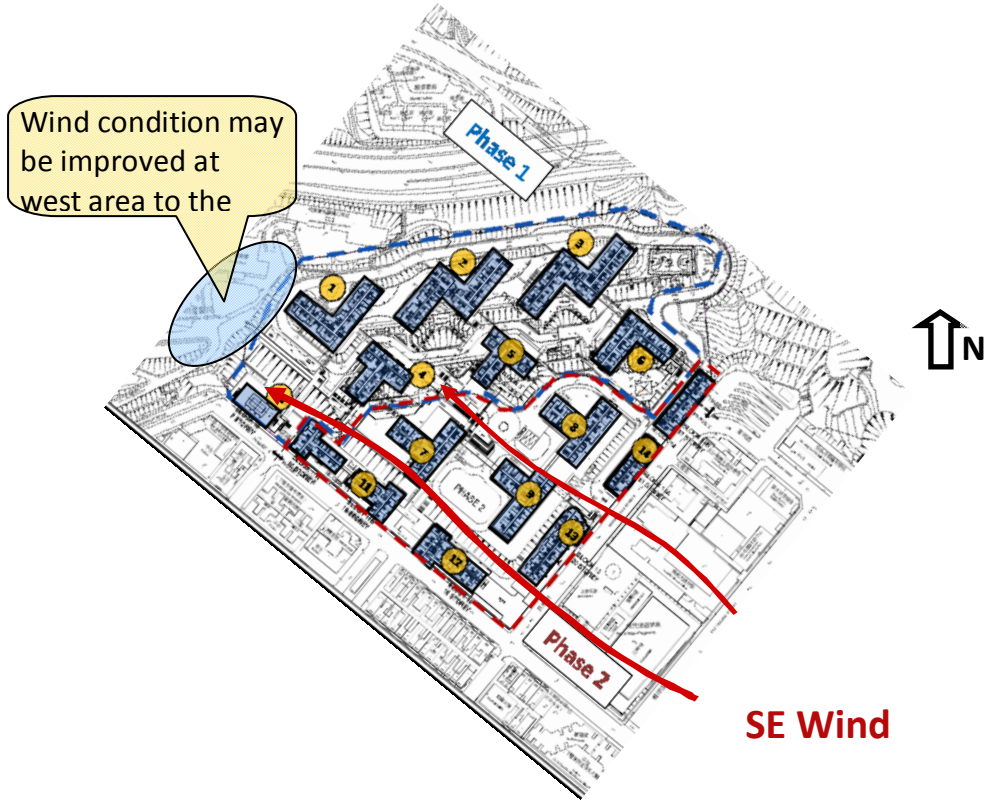

Figure 11 Wind corridors for penetration of SE wind through the site

Under SW wind condition, the building gap between Block 10 and Block 11 is connected to Cheung Wah Street. Therefore wind coming from SW can pass through this wind corridor. As can be seen from Figure 12, the ground level void of Block 1 and 4 could further enhance the wind performance by allowing more wind to penetrate. Therefore, the new So Uk development is unlikely to cause adverse effect to the ventilation of low-rise residential development at north of Ching Cheung Road. On the other hand, the building gap between Block 11 and Block 12 serves as major wind corridor for air penetration (Figure 12). The wind corridors can help to improve the wind condition at surrounding area north to the site.

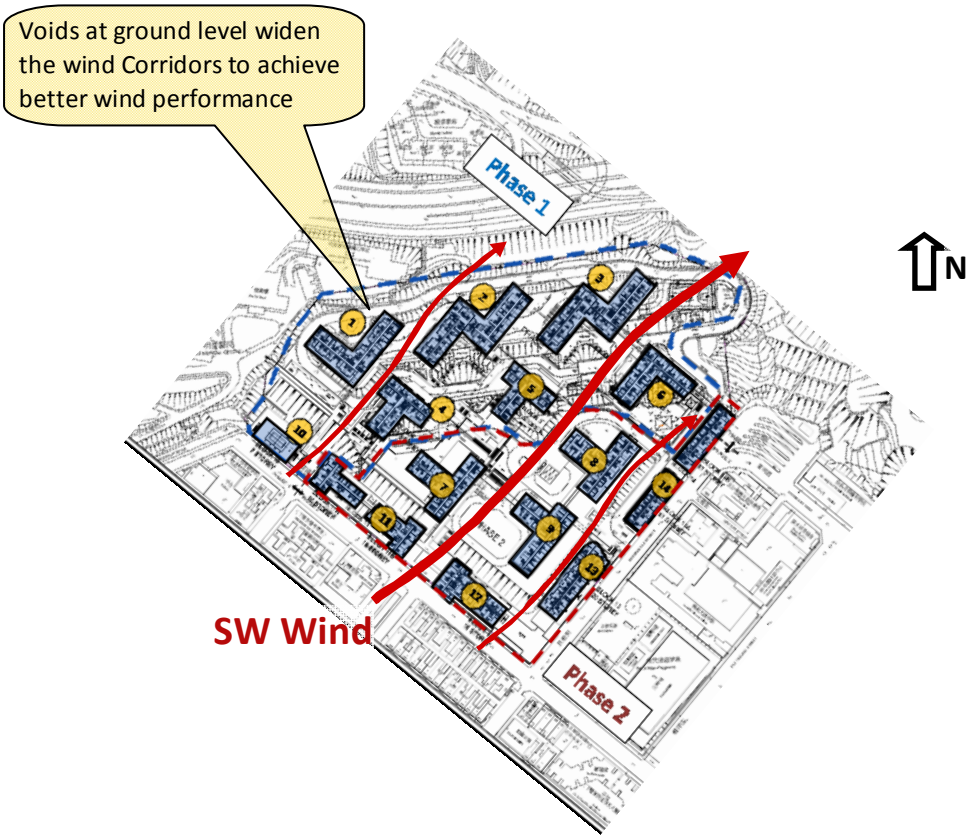

Figure 12 Wind corridors for penetration of SW wind through the site

4.4.2.1 Further Permeability Improvement

Ground floor ventilation corridors and ventilation bays at the podium levels are further improvement to a more permeable site. For building blocks 1 to 6, ground floor ventilation corridors are designed as highlighted in Figure 13. As a result, the wind corridor at ground level is widened. Under the E wind condition, the space between Blocks 1 to 3 and Blocks 4 to 6 can allow more wind to penetrate the site as indicated in Figure 13.

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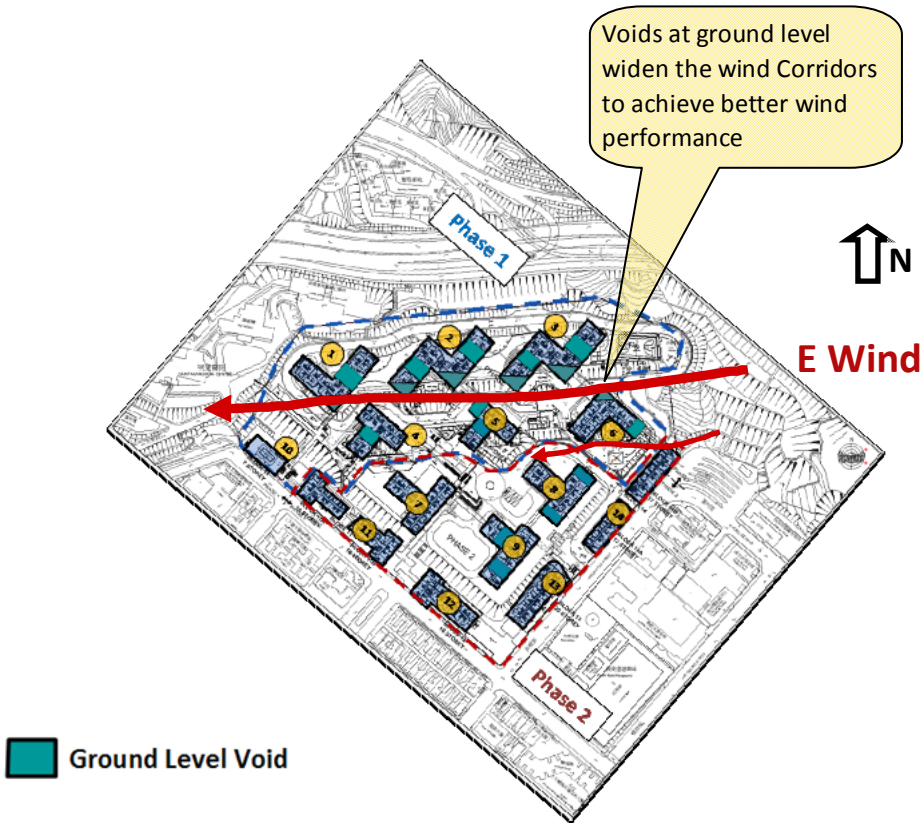

Figure 13 Ground floor ventilation corridor favors E wind to penetrate the site

Ventilation bays in Phase 2 are also important to the permeability of the development. The updated designs, ventilation bays and ground ventilation corridors, are added and emphasized for the buildings in Phase 2 and beneficially, the permeability of the site is improved (Figure 14- Figure 15)

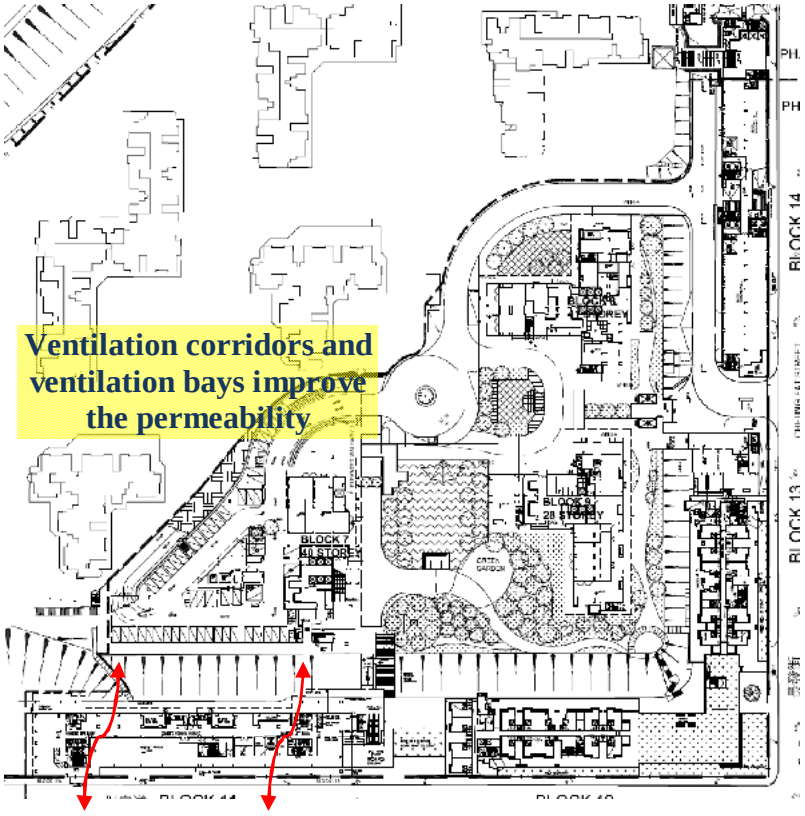

Figure 14 Ventilation bays at Floor F2 in Phase 2

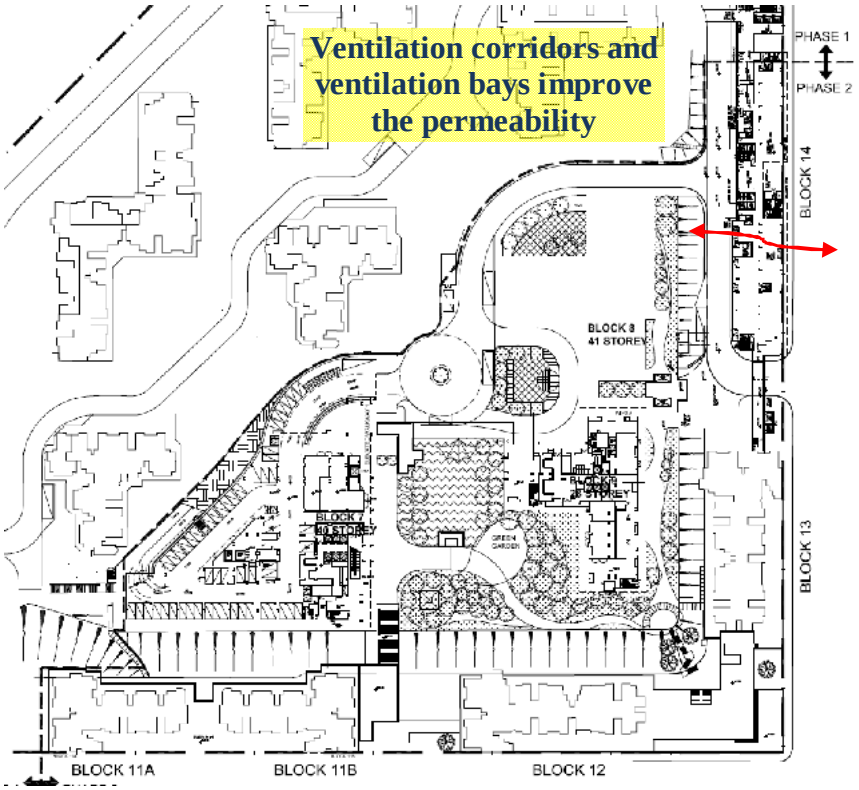

Figure 15 Ventilation bays at Podium in Phase 2

4.4.2.2 Height Variation

It is further noticed that the buildings blocks offers a general gradation of building height from south to north, helping downward wind flow and avoid air stagnation. This complies with the recommendation given in the "Urban Design Guideline", in which a decreasing height of buildings towards the direction of the prevailing wind is suggested.

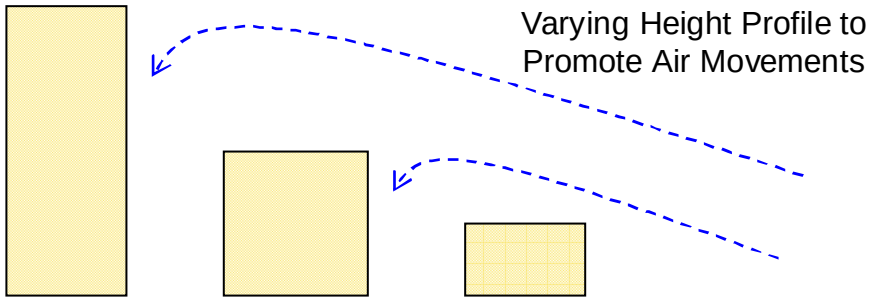

Figure 16 Gradation of building height to promote air movements

5 AVA initial study at the scheme design stage

The Expert Evaluation only aims at providing qualitative identification of wind performance of the site under existing condition and proposed design layout. To quantitatively estimate the wind performance at the pedestrian level and determine the airflow pattern, AVA Initial Study will be carried out at the later scheme design stage to provide better illustration of the air ventilation performance of the Development.

According to the Technical Circular, Computational Fluid Dynamics (CFD) coupled with meteorological data collected from the MM5 is considered as the appropriate tool for AVA Initial Study to determine the Velocity Ratios (VR) at different concerned locations. The model will contain information of the surrounding buildings and site topography from Geographical Information System (GIS) platform. The airflow distribution within the flow domain, being affected by the site-specific design and the nearby topography, will be visualized under the prevailing wind conditions round the year. Not as wind tunnel test, which could only provide wind velocity ratios at pre-determined discrete measurement points, CFD can perform graphical visualization of the overall airflow pattern of the studied site. This benefits designers on better and easy understanding of the wind performance of the site as well as studying different design options in an effective way, especially at concept and scheme design stages.

6 Conclusion

Qualitative assessment of the wind environment of the Redevelopment of So Uk Estate Phase 1 & 2 was conducted. The air ventilation impacts of the existing site condition as well as the proposed design scheme of the proposed development were studied.

According to the analysis, the wind majorly comes from NE, E, SE and SW. The air ventilation performance of the proposed design scheme would be better than the existing condition due to wider block separation and provision of wind corridors for these major wind directions. The orientation of building blocks also helps to allow more prevailing wind to enter the site and improve wind environment. As a result, the wind condition at the surrounding areas, such as Po On Road, the area west and north to the development site could be improved. In the mean time, the development is unlikely to cause adverse effect to the ventilation of low-rise residential development at north of Ching Cheung Road.

To further enhance the ventilation performance, some other design features could further enhance the permeability of site. They include:

1) Widened wind corridors at ground level due to ground floor voids in Phase 1
2) Ground floor ventilation corridors and ventilation bays at podium level
3) Height variation along the prevailing wind direction to help downward wind flow and avoid air stagnation

To quantitatively assess the air ventilation performance of the Development as well as concerned areas surrounding the site, AVA Initial Study using Computational Fluid Dynamics (CFD) technique will be carried out in the later stage.