Policies towards Greening, Permeability and Building Separation for Better City Planning in Hong Kong

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ABSTRACT

Sustainable building and urban living space issues are complex and broad subject matters. The Study reported here is only one of the initiatives under the Government of Hong Kong SAR to address the notion of sustainable urban living space which is widely demanded-for improvement. The quality of urban living environment in general such as urban air ventilation, heat island effect, urban greenery and pedestrian environment are significant "local issues" that affect livability and our health. The Study formulates a number of recommendations regarding building permeability and separation, building site coverage and greenery; only urban air ventilation recommendations of the study will be reported in this paper. As of May 2009, the recommendations are being publicly debated in Hong Kong. Upon the completion of the consultation process by the end of 2009, the government of Hong Kong is going to formulate policies and strategies to implement the recommendations.

Background

Sustainable building and urban living space issues are complex and broad subject matters. This background outlines the purpose of the Study, highlighting that the scope of the Study is only one of the initiatives under the Government of Hong Kong SAR to address the notion of sustainable urban living space which is widely demanded for improvement.

While recognizing the significance of the issue in relation to the sustainable development of Hong Kong, this Study as commissioned under the Buildings Department (BD) is subject to various limits. It represents a starting point for further investigations and discussions, which will definitely further require a more integrated, holistic framework from the higher level of the Hong Kong SAR Government as well as the synergy of the concerned Government departments and related stakeholders in order to optimize the effectiveness of improving the sustainability of urban living space in Hong Kong.

In the Policy Address 2006-07 of the Hong Kong SAR Government (Policy 2006), one of the priority issues is "Quality Environment". It states: "*Hong Kong deserves and can afford a better living environment today. We must secure sustainable development for our future generations…… There exists a strong community consensus on the pressing need to take decisive measures to improve air quality and our environment generally…… What is important is to focus on the overall strategic direction, set targets for different stages, establish guiding principles and introduce specific policy initiatives for environmental protection……. Environmental protection is a long-term undertaking. First, we must adopt a forward-looking strategic approach by setting* *improvement goals for different stages*......" The Government also commits to "*adopt the concept of greening of rooftops whenever practicable in the design of new buildings. We are studying the wider application of the concept with a view to encouraging more projects to adopt this approach*."

According to the "First Annual Implementation Progress May 2006", Buildings Department o the Hong Kong SAR Government commissioned a study on sustainable building design, for the purpose of promoting sustainable building design features and developing sustainable building design guidelines. By the end of 2008, the Study draws up recommendations for improvement, including an assessment of the implications of setting mandatory requirements in this area for the Government's consideration. The Study is considered a focused research in relation to how new building design can support sustainable urban living space.

Sustainable Urban Living

Sustainable urban living space relates to the living and working environment that supports the sustainable development of the city. According to SUSDEV 21, "Sustainable Development in Hong Kong (Susdev21, 1997) balances social, economic and environmental needs, both for present and future generations, simultaneously achieving a vibrant economy, social progress and better environmental quality, locally, nationally and internationally, through the efforts of the community and the Government." Sustainable development therefore requires full integration of the needs for economic and social development with that for conservation of the environment. It means: (a) Finding ways to increase prosperity and improve the quality of life while reducing overall pollution and waste; (b) Meeting our own needs and aspirations without doing damage to the prospects of future generations; and (c) Reducing the environmental burden we put on our neighbours and helping to preserve common resources." (1999 Policy Address of HK Government)

Sustainable Urban Living Space has an interrelationship with environmental, economic and social attributes of the society. It should be able to encourage pluralism and dynamism, accommodate flexibility for innovative ideas and possibilities for a high quality built environment that commensurate with the natural setting, meeting social and economic needs and stimulating improvements. Key considerations that should be given to achieve sustainable urban living space include nature conservation and environmental protection, micro-climate, breezeway and view corridors, density and massing of building development, transport infrastructure and congestion, reclamation and use of harbour front, conservation of heritage and local character, coherence and compatibility of land use and built form, pedestrian and community-oriented city space and networks, urban amenities and public realm, diversity of economic activities and choices, etc.

Sustainable Urban Living Space can be achieved by the combined efforts of town planning and urban design, building design, transport planning supported by policies on energy, transport, land administration, environmental protection, social and economic development, etc. Town planning and urban design provides a framework for physical and spatial arrangement of built forms and their 3-demensional relationship with spaces and surrounding setting to achieve aesthetic and socio-cultural qualities. Building design manifests such relationship within private space and beyond to integrate with public space, to explicate innovative ideas that are beneficial to environmental, social and economic sustainability.

Sustainable Buildings

In the context of this Study, a "sustainable building" maintains performance levels over its entire life that support the broader sustainability goals of Hong Kong, as suggested but not limited to the four generic urban living space problems as identified in relation to The First Sustainable Development Strategy for Hong Kong (Sustain, 2005). In these terms, a "sustainable building" in Hong Kong has consequence at four (4) interrelated scales: global, regional, local and internal. In the light of the above considerations, the definition of "sustainable building" is as: Over its entire life, a "sustainable" building maintains environmental performance levels and enhances the quality of public communal spaces for socio-economic benefits, thereby in support of the broader sustainability goals of Hong Kong. In these terms, a "sustainable building" in Hong Kong explicitly addresses the key generic urban living space problems and has positive direct and indirect environmental, social and economic consequences and benefits at four interrelated scales:

Globally, in terms of Hong Kong's role and responsibility within the international community in combating global environmental degradation and climate change by reducing its national greenhouse gas (GHG) emissions. A "sustainable building" reduces life-cycle greenhouse gas emissions in its design, construction and operation.

Regionally, in the extent that the built environment both supports Hong Kong's economy by reducing the imports of energy, material and water resources from afar and preserves and, where possible, restores its inherent natural features for the continuous benefits of its own citizens and as an attractive destination for visitors. A "sustainable building" reduces life-cycle energy, material and water use.

Locally, in the way the built environment creates attractive and comfortable urban living spaces and assists in providing a healthier physical and psychological neighborhood context. A "sustainable building" integrates with its context in a manner that improves urban climate (enhancing air ventilation, mitigating heat island effect, decreasing polluted runoff and air exhaust emission, etc.), enhances the overall quality and comfort in surrounding public spaces and pedestrian areas (for promoting social interaction and integration, accessibility for all, pedestrian activities, local economy, etc.), and provides natural/green space and other physical amenities for pedestrian/neighborhood benefit and enjoyment. It should be sited and shaped to protect the ridgeline and view corridors with consideration to the wider urban context.

Internally, in the creation of healthy and comfortable interior spaces that enable buildings to maintain their asset value, a "sustainable building" provides access to daylight and natural ventilation in primary interior spaces to contribute to the physical and mental health and wellbeing of building occupants. It allows for accessibility and flexible use of space to meet social and community needs and to enhance social integration and equity.

The Study focuses on the local scale and specifically on how new building design can support more sustainable urban living space.

The proposed definition at the local level is intended to reflect the overall sustainable city program goals of HK. To achieve such goals in relation to urban living space, an effective approach is to promote both sustainable urban planning and sustainable building design practice in a synchronized manner. This Study is limited to address the new building design practice, though. The key generic urban living space problems are identified on the basis of expert opinions (both local and international ones) and with reference to local references.

The proposed definition is structured in a way that allows refinement over time. The intention is to reflect the priority urban living space issues and the consequential environmental and socio-economic benefits that the local community at large values. Overall, it aspires to create the local built environment with attractive and comfortable urban living spaces and a healthier physical and psychological neighborhood context. As shown in the proposed definition, the identified key generic urban living space concerns include the following four (3) broad aspects:

(a) Urban Climate - Urban climate issues with priority placed upon enhancing air ventilation and mitigating heat island effect.
(b) Pedestrian / Public Space - Quality and comfort in surrounding public spaces and pedestrian areas that are conducive to a sense of place, accessibility and vitality.
(c) Urban Greenery - Provision of more natural / green space for pedestrian and neighborhood benefit and enjoyment.

In order to address the above generic urban living space issues, an effective approach is to promote both sustainable urban planning and sustainable building design practice. The fourth aspect about the protection of ridgeline and view corridors appears to be more site / district specific, and urban planning will be the proper and effective measure to control. With respect the other three aspects, both urban planning and building design can contribute. The Study focuses on how new building design can support these generic concerns, despite recognizing the fact that individual developments are mostly confined within their respective site boundary to offer the interventions.

Recommendations – Urban Living Space

"Sustainable urban living space" is defined to be the specific concern for investigation in this case. Other sustainability issues are considered of importance but will not be addressed in this Study. With respect to "sustainable urban living space", the range of issues may include the following key concerns:

(a) Urban climate (air ventilation, heat island effect,, etc.);
(b) Pedestrian environment / public space;
(c) Urban greenery;
(d) Cityscape, light pollution, building aesthetics, etc.;
(e) Local transport / commuting / accessibility;
(f) Public hygiene (pollutants, discharges, emissions, refuse, etc.); and
(g) Other socio-economic aspects.

All of the above issues are of importance to different extent, and some of them have been addressed by the concerned government bodies under the relevant ordinances / regulations / PNAPs already in place, especially with respect to the public hygiene issues. Given the resource and time limit of the Study, priorities have to be identified. Through the first stakeholder consultation exercise held in early August 2006, the key generic urban living space issues relating to new building design are consulted and prioritized. The findings reinforce the outcome of the First Sustainable Development Strategy for Hong Kong (2005). The priority placed on urban climate and greenery are also shared by cities including Tokyo and Singapore as revealed in the overseas review of the Study, while the undesirable pedestrian environment / public space is a particularly difficult problem in Hong Kong given its extremely high density in the Metro urban area. (Tokyo, 2005) (BD, 2005) (Singapore Green, 2003) Three key priority urban problems in Hong Kong are highlighted as below for further investigation in the Study:

(a) Undesirable air ventilation and heat island effect;
(b) Undesirable pedestrian environment / public space (especially in Metro urban area); and
(c) Lack of greenery.

While these three issues are all considered the top priorities in Hong Kong, air ventilation and related urban climate matter represent the topmost concern and pedestrian environment / public space closely follows as the next topmost concern. The Study focuses on the "building sector objectives" that are intended to support the wider sustainable city goals. The corresponding "building sector objectives" are proposed as follows:

(a) Promoting building design that facilitates better air ventilation;
(b) Promoting building design that mitigates the heat island effect;
(c) Promoting building design that enhances the pedestrian environment/public urban space;
(d) Promoting building design that provides more greenery.

Recommendations – Better Air Ventilation

Through the recent consultancy study as commissioned by the Planning Department (2003-2005), the feasibility study of establishing an air ventilation assessment system in Hong Kong has been carried out. (Ng, 2009) (Ng, 2004) Based on the local and international expert review, the performance-based indicator in term of "Wind Velocity Ratio" (VR) of wind is introduced to scientifically quantify the impact of built development on the surroundings. It is now coined as the Air Ventilation Assessment (AVA).

The feasibility study has identified that in the particular context of Hong Kong, an emphasis should be placed on the street / pedestrian level which represents the focus of public concern with respect to the quality of urban air and public space. In the typical street canyons of Hong Kong, air pollutants tend to be trapped in the bottom 15m. For narrow and deep street canyons (H:W>2:1), the pollutant dispersion will be difficult at the pedestrian / bottom level. For public health and comfort, it is therefore necessary to: 1. Improve the permeability of urban fabric, and 2. Increase the air volume, especially at the pedestrian level to minimize any stagnant zones.

Regarding the performance benchmarking aspect, it requires further extensive consultancy work to collect the local data for analysis and consultation. This benchmark development work belongs to the second stage of air ventilation study as commissioned under a separate consultancy by the Planning Department. The follow-up study, titled as "Urban Climatic Map and Standards for Wind Environment – Feasibility Study", is to be carried out from July 2006 to mid 2009.

At this interim stage, the expert opinion together with preliminary parametric study based on CFD modeling is that 20-30% permeability is considered a reasonable scientific baseline (see

Appendix F for more details). The range of 20-25% permeability is similar to the openness of the existing urban grids in districts like Mongkok, where the older buildings are normally up to about 60m only. Given the sub-tropical climate and urban density in Hong Kong, higher permeability especially at the pedestrian level should be promoted – the more wind, the better the urban living environment.

For recommended good practice, according to the feasibility study of establishing an air ventilation assessment system in Hong Kong, the expert opinion for the prevalent high-rise developments (commonly over 20 storeys) is as below: "Where practicable, adequately wide gaps should be provided between building blocks to maximize the air permeability of the development and minimize its impact on wind capturing potential of adjacent developments. As a rule of thumb, the gap between two building blocks should be ideally equivalent to 50% of the combined width of the two blocks. The gaps for enhancing air permeability are preferably provided with the largest permeable area perpendicular to the prevailing wind." (The equivalent permeability is 33%.) The 2-year "Feasibility Study of Establishment of Air Ventilation Assessment System" has developed certain design features with specific reference to the high-density urban context in Hong Kong. At the individual building scale, the list of relevant key design principles can be summarized as below:

(a) "Permeability" along the major breezeway (dependent on prevailing wind directions and sea breeze situation) is the priority.
(b) "Permeability" at the pedestrian / lower level is of greater significance, in comparison with that at the higher building level.
(c) Larger "air volume" is in need at the pedestrian / lower level, especially for the situation where narrow streets with vehicular traffic form deep street canyons with air pollutants and heat trapped.
(d) "Permeability" at the higher building level is in need to safeguard the air ventilation in the local spatial environment.

The basic concern is to minimize any adverse wall effects at both lower and upper levels, with particular attention to the prevailing wind directions and waterfront conditions. Where street canyons are unavoidable especially in Metro urban area, larger air volume at the lower level should be promoted.

A street canyon is a canyon (a deep narrow valley) formed in a street between tall buildings on both sides. The important geometrical feature of a street canyon, aspect ratio (H/W), is the major parameter influencing air ventilation between the buildings, where H and W are the height of buildings and the width of a street respectively. For canyons aspect ratio higher than 2, the air flow above building height will become highly difficult to reach the pedestrian level where the buildings are tightly packed to form a narrow street, especially when the flow is perpendicular to the axis of the canyon.

Corresponding to the above design principles, the list of building design features, applicable to both domestic and non-domestic buildings, potentially includes the following. They can be categorized into two aspects: "Pedestrian Zone" (ground to 15m zone) and "Lower Zone" (say, 15m – 60m zone). The proposed 60m datum is roughly equivalent to the height of a typical existing 20-storey building built in the past decades in the urban area of Hong Kong. The intention is to safeguard reasonable wind availability to the majority of existing building stock in our city.

· Pedestrian Zone

- Building set-back: Reduced site coverage at ground level facing streets / major pedestrian ways.
- Split podium: Instead of a single podium with full site coverage across the entire site, especially providing permeability for breezeway/ sea breeze to pass through the site.
- Stepped podium profile: Reduced site coverage at podium levels above ground level facing streets / major pedestrian ways.
- Void deck Provision of openings at ground / major pedestrian level for cross ventilation to wash out the street directly.

· Upper and Lower Zones

- Building set-back Setback from streets, especially for widening the breezeway.
- Gap / separation between Towers Instead of a substantial wall effect, especially for facilitating the prevailing wind / sea breeze to pass through.
- Varied / stepped building profile Mixture of towers at different building heights with the principle that the height decreases towards the direction where prevailing wind comes from.
- Sky gardens / refuge floors Provision of openings at the upper levels for cross ventilation.
- Podium roof gardens under towers Open-sided above safe parapet for cross ventilation / loftier podium roof gardens by raised tower design to achieve better cross ventilation.

Since air ventilation is regarded as the top priority concern in Hong Kong, it appears to have wide public support for the Government to step up the relevant measures as appropriate. Owing to the fact that the local performance benchmarking is under scientific investigation by the Planning Department through the follow-up AVA consultancy study until 2009, an interim recommendation is to adopt the indicator of "building permeability" for guiding building design to achieve reasonable performance of air ventilation. The preliminary guidelines are as below:

Design Guideline for "Long Buildings"

The building permeability requirement will be applicable to all new development sites equal to or larger than 2ha. For individual site of new development smaller than 2 ha, the requirement is applicable wherever there is any "continuous projected facade length"longer than 60m. 'Continuous projected facade length' is defined to be the total projected length of facade of a building or buildings if any separation in-between is less than 15m. The following shows the requirements in relation to building height and site area, taking into account the considerations of wind science and practicality, e.g., the concern about design constraints in smaller sites:

Table 1. Building Height and Permeability

Building Height (H)	Building Permeability (P)	
	For site < 2 ha.AND with any continuous projected facade length >= 60m	For site <=2 ha.
<= 60m	1/5 or 20%	1/4 or 25%
> 60m	1/5 or 20%	1/3 or 25%

Further to the definition of continuous projected facade length (Lp), the building permeability requirement is based on a combined consideration of building height (related to the implication on air ventilation) and site area (related to design flexibility and practicality concerns, especially in smaller sites). For smaller sites (say < 2 ha.), a minimum building permeability (say, P ≥ 20%) is required regardless of building height; and the proposed threshold for Lp in this kind of smaller sites is based on local practicality considerations and relevant overseas reference in view of HK's prevalently highrise context. In Hong Kong, the length of street block in older urban areas is around 60m and typical frontage of a highrise residential tower is about 35-50m. Therefore, the recommended 60m threshold for accountable Lp in smaller sites less than 2 ha. can practically address the situation like where more than one such tower may be closely packed together to form a wall-like effect.

For larger sites (say, ≥ 2 ha.), regardless of Lp, a medium building permeability (say, P ≥25%) is required when H ≤ 60m while a higher building permeability (say, P ≥ 33.3%) is required when H > 60m. The application shall also follow the four (4) design principles as outlined below:

Design Principle 1: Building Separation (S)

The required building permeability shall firstly be provided in form of building separation (S), the accountable width of which is proportional to the length of adjoining facades in accordance with the stipulated building permeability criteria and in no case smaller than 15m. For the immediate context taken into account, the 1/2S criteria can be applied to the facade ends with separation distance measured from the adjoining boundary line or the centerline of adjoining street. The building permeability provides "air paths" through development site to the neighbouring area.

Figure 1. Building Separation (S) requirement for different continuous projected facade length (Lp) at different Building Permeability (P).

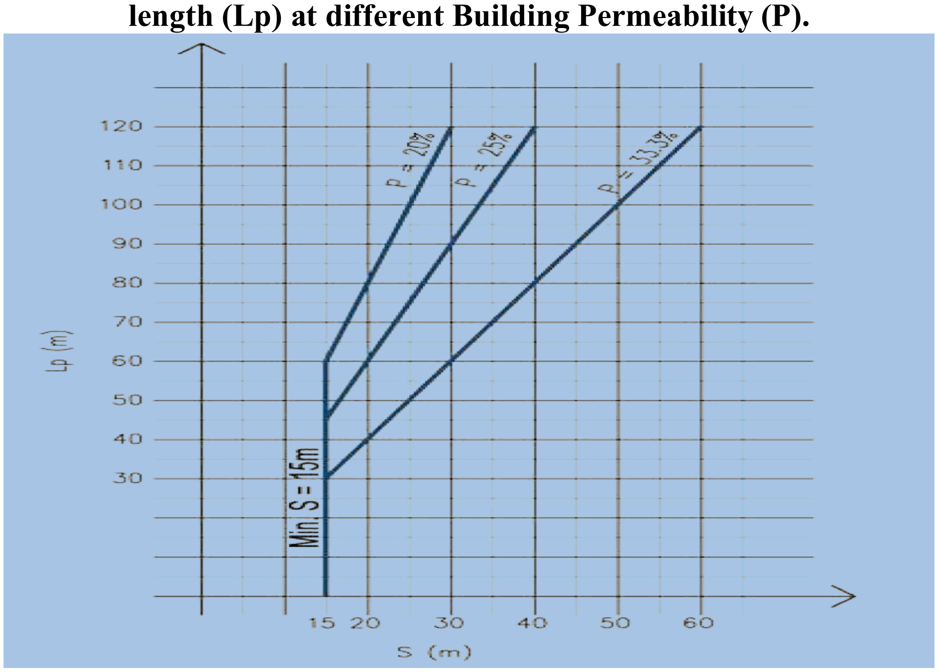
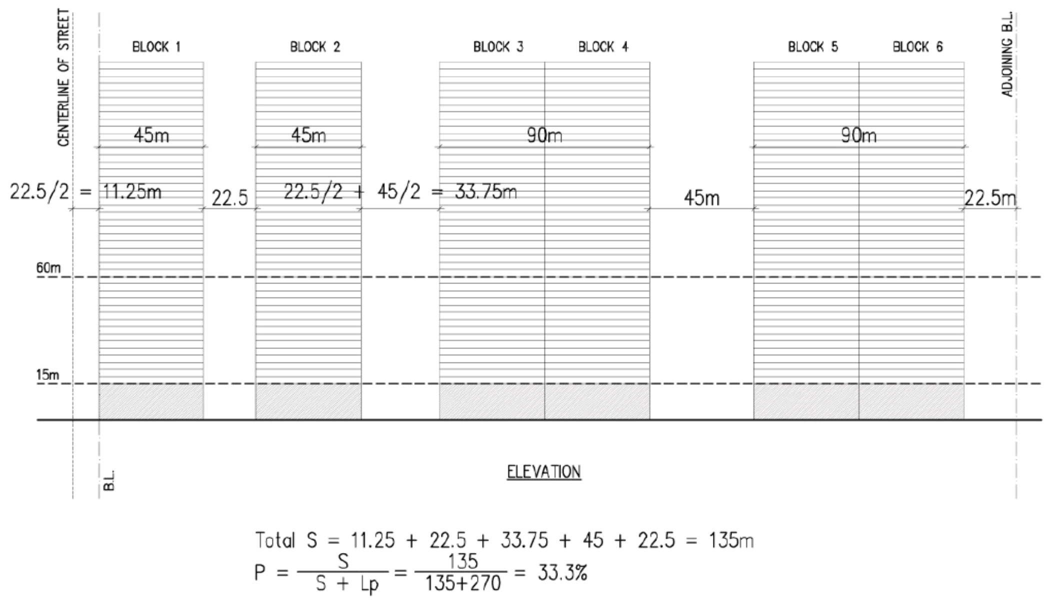


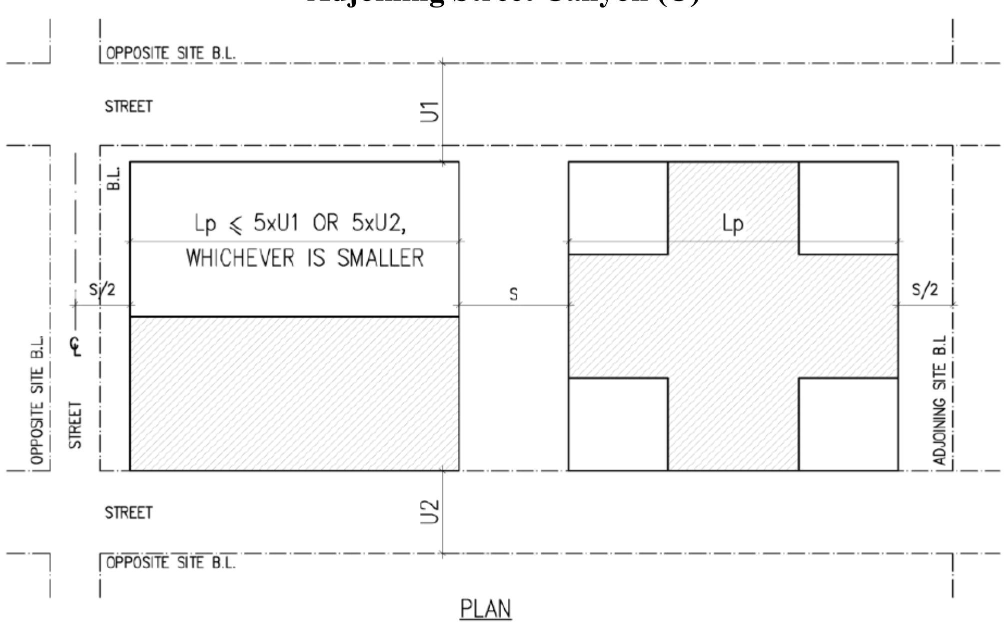
Figure 2. Example of building separation (S) calculation: H > 60m & Site > 2 ha [i.e., building permeability (P) ≥ 33.3%]



Design Principle 2: Maximum Permissible Length of Lp

While the permissible length of individual facade (L) is governed by the design principle 1 in relation to the width of building separation (S), another contextual consideration relates to the maximum permissible Lp to the size of street canyons, if any, faced by the concerned facade. Lp shall not be larger than 5 times of the mean width of the adjoining street canyons.

Figure 3. Relationship between Overall Continuous Facade Length (Lp) and the Size of Adjoining Street Canyon (U)



Design Principle 3: Design Alternative to Building Separation

While building separation (S) is considered the most direct and effective means for air ventilation in the high-rise context of Hong Kong, design flexibility can be allowed to slightly vary the stipulated building separation area (say, up to 1/3rd of the stipulated minimum area) provided that the permeability area is offset within the adjoining façade zones defined by both vertical and horizontal zoning. The facade zones are vertically divided into three levels, given the consideration of the prevalent form of the urban context and environmental condition in Hong Kong:

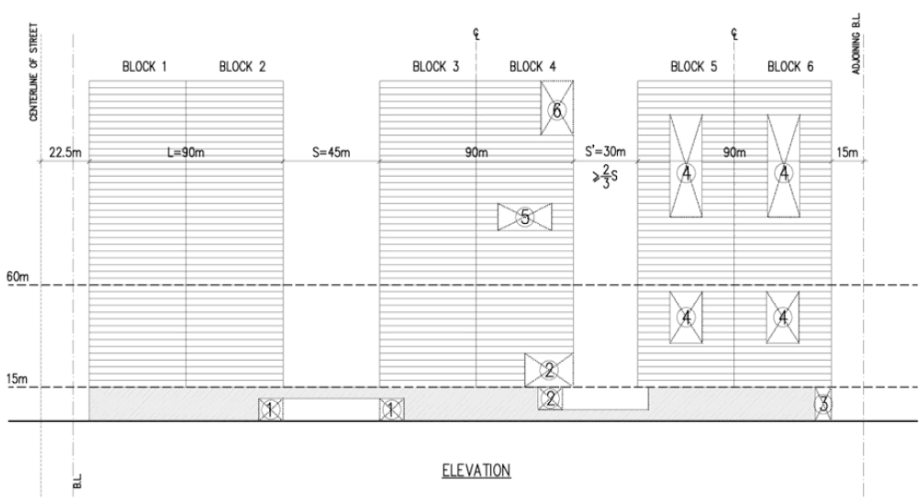
Table 2. Vertical Zones and Design Features for Air Ventilation

Vertical Zone	Height range	Design Features #
Pedestrian	10-15m	Void deck, Building setback, Podium garden with cross ventilation design
Lower	15-60m	Podium garden with cross ventilation design, Building setback, Sky garden, Refuge floor, Varied building profile
Upper	Above 60m	Building setback, Sky garden, Refuge floor, Varied building profile

 # The permeability area of design features should be determined by their respective open area for effective cross ventilation. Reduction factor may have to be further considered for very small openings. As a preliminary indicator, 3m clear height and width can be considered as the minimum dimension of individual open area to be accountable. Permeable railing design or similar can be reasonably accepted as long as such provision will not materially affect the ventilation performance of the concerned opening.

Horizontally, the facade zone is divided by the centerline of the facade surfaces in-between the respective building separations. Typical means to offset the permeability area of building separation (Fig. 5.9) include the following options:

Figure 4. Typical Alternative Means to Offset Building Permeability (P): 1. Void deck; 2. Podium garden; 3. Building setback; 4. Sky garden; 5. Refuge floor; and 6. Varied building profile

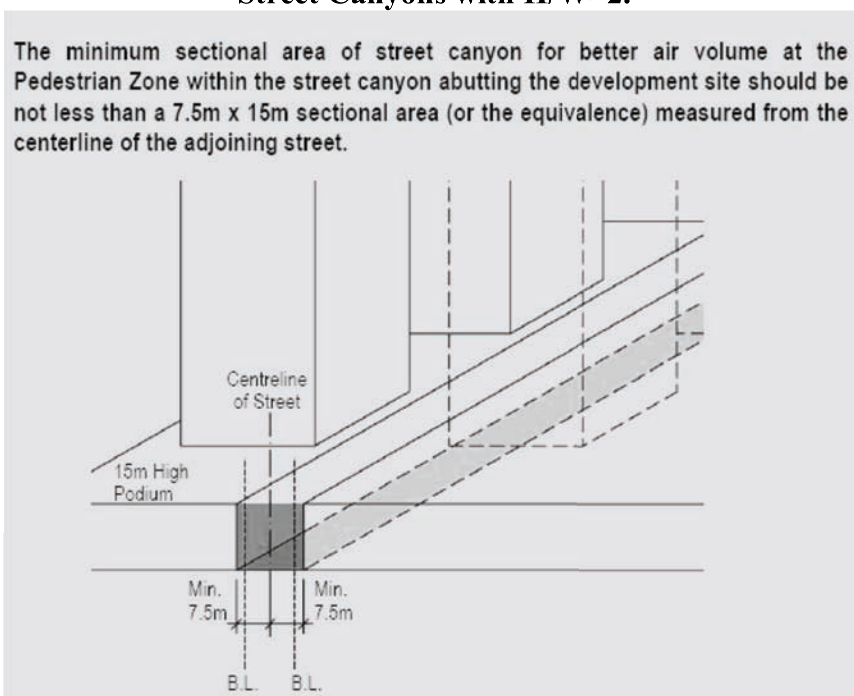


Design Principle 4: Performance-based Design Alternative

Since the performance-based method for AVA system has been developed under the feasibility study of the Planning Department, any special design (e.g., split podium design cannot be done for a mass transit station or depot, large sports facilities or civic centre), can take the alternative approach as long as an equivalent or better performance in term of air ventilation is achievable by comparison through wind tunnel modeling or computational fluid dynamic (CFD) testing.

For development sites where most pedestrians are planned at an elevated level rather than at grade, justification can be made case by case to demonstrate that the building portion below such major pedestrian level will not cause any material concern to sensitive users with respect to the performance of air ventilation. As such, the building separation requirement may be favorably exempted by the relevant authority for the concerned building mass at a lower level.

Figure 5. Design Guideline for Sites in Urban Areas Facing Harrow Streets Forming Deep Street Canyons with H/W>2.



Note:
The above requirement is based on the following two assumptions:
1. Similar building setback at the "Pedestrian Zone" will be provided at both sides of a narrow street over time, so that an effective air volume at a cross sectional area of 15m x 15m will be achieved in the bottom of deep street canyons as the baseline to improve the air ventilation.
2. This 15m x 15m sectional area of street concept is applicable to the typical urban context in Hong Kong where the podium is 15m high and the towers are located above with gaps in-between.

Some local, as-built developments in large sites with potential "wall effect" concern with respect to air ventilation should be separately reviewed to assess the implications. In case where the site constraints are high (e.g., development at a very small site with hardship in accommodating necessary functional areas at the G/F and podium levels if setback were required), the approval authority should have the discretion to accept a lower requirement to suit specific cases. Exemption can be considered on individual merits of each case. Special circumstances such as the physical location, immediate environs and conservation of heritage of a development site as well as particular functional requirements may render the compliance impracticable or impose unjustifiable hardship.

In connection with narrow street canyons, projecting signboards of large size will further block the air flow near the pedestrian zone. Vertical signboards are preferable from the perspective of air ventilation. Separate study is required to inform further understanding of their implications.

Implementation

As of May 2009, the recommendations are being publicly consulted in Hong Kong. Upon the completion of the consultation process by the end of 2009, the government of Hong Kong is going to formulate policies and strategies to implement the recommendations.

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