

**Lighting and Ventilation Requirements – Performance-based Approach**

The Buildings Department completed a consultancy study to review the standards of the lighting and ventilation requirements in buildings in 2003. Based on the findings of the consultancy study, the Building Authority (BA) is prepared to accept the following alternative performance standards on the provision of natural lighting and ventilation in habitable rooms and domestic kitchens for the purpose of Regulations 30, 31 and 32 of the Building (Planning) Regulations (B(P)R):

(a) Natural Lighting

<i>Room of domestic building</i>	<i>Vertical Daylight Factor (VDF)<sup>1</sup> (measurement taken on the centre of the window pane)</i>
Habitable Room	8%
Kitchen	4%

(b) Natural Ventilation

<i>Room of domestic building</i>	<i>Air Change per Hour (ACH)</i>
Habitable Room	1.5 (natural means)
Kitchen	1.5 (natural means) plus 5 (mechanical means)

2. The BA would accept proposals based on the above standards. Applications to modify the prescriptive requirements set out in Regulations 30, 31 and 32 of the B(P)R will be accepted if the above performance standards are met. The Authorized Persons (APs) may demonstrate compliance using any suitably verified and scientifically validated methods. To assist APs in adopting the above performance-based approach in design, guidelines for a simplified assessment method and guidance notes on validation of lighting simulation are given in Appendices A and B respectively.

3. The BA has no objection to accepting the design of a project partly based on the prescriptive requirements and partly based on the performance standards set out in paragraph 1. For the purpose of Regulation 31(2) of the B(P)R, the base may be measured at an angle not more than 15° from the external wall.

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<sup>1</sup> "Vertical Daylight Factor" means the ratio in percentage of the total amount of illuminance falling onto a vertical surface of a building to the instantaneous horizontal illuminance from a complete hemisphere of sky excluding direct sunlight. It takes into account light coming from the sky directly and from reflected light of surrounding buildings and the ground both above and below the horizon.

4. The need for any refinement to the standards and replacement of the current prescriptive regulations would be considered when a review on the application of the alternative performance standards has been conducted.

5. In the case of wholesale conversion of existing industrial buildings or other types of buildings to office use where there are difficulties in providing the required natural lighting and ventilation due to constraints posed by the original design of the existing building, application for modification of Regulations 30 and 31 of the B(P)R will be favourably considered if adequate artificial lighting and mechanical ventilation and energy efficient design that could achieve 40% in the categories of Energy Use (EU) and Indoor Environmental Quality (IEQ) with the BEAM Plus Certification conferred by the Hong Kong Green Building Council (HKGBC) are incorporated in the proposal. As the pre-requisites for the granting of the modification, the applicant in applying for approval of plans should submit the official letter issued by the HKGBC acknowledging the satisfactory completion of project registration application for BEAM Plus Certification and a letter by the applicant undertaking to submit to the BD the following documents:

- (a) Result of the Provisional Assessment under the BEAM Plus Certification conferred by the HKGBC to demonstrate achievement of 40% in the categories of EU and IEQ to be submitted prior to the application for consent to the commencement of the building works shown on the approved plans; and
- (b) Result of the Final Assessment under the BEAM Plus Certification conferred by the HKGBC to demonstrate achievement of 40% in the categories of EU and IEQ within 6 months of the date of the BA's letter of acknowledgment of the Form BA14 for the project.



( AU Choi-kai )  
Building Authority

Ref : BD GP/BREG/P/42  
BD GP/BREG/P/18/1(E) (IV)  
BD GP/BREG/P/18/1(G) (II)

This PNAP is previously known as PNAP 278

First issue December 2003

Last revision September 2010

This revision June 2013 (AD/NB1) (Paras. 1 to 5 amended and previous para. 5 deleted)

## **GUIDE ON THE ADOPTION OF PERFORMANCE STANDARDS**

### **PART I**

#### **1. Introduction**

- 1.1 This guide gives guidance on how the performance requirements on natural lighting and ventilation in buildings may be met.

#### **2. Performance Requirements**

- 2.1 The BA recognizes that a performance-based approach to the provision of natural lighting and ventilation in buildings is an acceptable alternative option in satisfying the health and safety requirements. The BA will accept a proposal meeting the following performance standards as an acceptable practice in fulfilling the requirements of B(P)Reg. 30, 31 & 32:

a) Natural Lighting

<i>Room of domestic building</i>	<i>Vertical Daylight Factor (VDF) (measurement taken on the centre of the window pane)</i>
Habitable Room	8%
Kitchen	4%

b) Natural Ventilation

<i>Room of domestic building</i>	<i>Air Change per Hour (ACH)</i>
Habitable Room	1.5 (natural means )
Kitchen	1.5 (natural means ) plus 5 (mechanical means)

- 2.2 The performance standards are deemed to be met if it can be proved that the provision of window(s) meets the simplified test on natural lighting requirements stipulated in Part II and the ventilation requirements stipulated in Part III.
- 2.3 There are a number of assessment tools available in the market for assessment of the performance of lighting in buildings. Consideration for acceptance will be given if the validity and appropriateness of the tools are substantiated to the satisfaction of the BA. In this respect, guidance notes on validation are at Appendix B.

#### **3. Interpretation**

**“Centre line of street”** is half distance of the 2 opposite lot boundaries with a street in between.

**“Cross ventilation”** means the situation in which outdoor air can flow from the window opening(s) in the front half of the room (the primary opening),

through the room, and out via the other window opening(s) located in the rear half of the room (the secondary opening) which is not located on the same plane of the primary opening(s).

**"Height of facade"**, when used in relation to the natural lighting and ventilation requirements, means the height of a building measured from the top of the window head at the lowermost storey in which the window is provided to the top of the parapet of the main roof of the building.

**"Illuminance"** means the amount of light falling on a surface.

**"Open air"** has the same meaning as defined in Regulation 2 of the B(P)Reg.

**"Primary opening"** means any window opening which is located in or within 1.5 m from end of the external wall where the window locates and satisfying the natural lighting requirements stipulated under the B(P)Reg or in Paragraph 2.1(a).

**"Secondary opening"** means any window opening which is located at an external wall, other than that defined for the primary opening, in the rear half of the room and facing open air.

**"Vertical Daylight Factor"** means the ratio in percentage of the total amount of illuminance falling onto a vertical surface of a building to the instantaneous horizontal illuminance from a complete hemisphere of sky excluding direct sunlight. It takes into account light coming from the sky directly and from reflected light of surrounding buildings and the ground both above and below the horizon.

**"Window sill"**, when used in relation to the window for achieving natural lighting and ventilation, means the lowermost level of the glazing in the room for which the window is provided.

## **PART II**

### **4. Provision of Natural Lighting**

Whilst there are a number of assessment tools available in the market for assessment of the performance of lighting in buildings, the BA will accept the "Unobstructed Vision Area" method as a reliable way to demonstrate compliance with the performance requirements. For other assessment tools such as computer simulation software, consideration for acceptance will also be given if the validity and appropriateness of the tools proposed are substantiated to the satisfaction of the BA.

#### ***The Unobstructed Vision Area Method***

4.2 The Unobstructed Vision Area (UVA) method is scientifically developed with respect to the following:

## Daylight in Hong Kong

- a) The amount of light receivable at the surface of a building facade is related to the extent of its exposure to the natural environment. Most of the natural light for windows of lower floors in the dense, high-rise development comes from reflected light of the surrounding surfaces. The amount of this reflected light is dependent on how well these surrounding surfaces are illuminated (which are in turn dependent on both site and building layouts) and the reflectance of these surfaces.
- b) Moreover, most useful light entering the glazing into building interiors comes from a cone of light 100 degrees centered to the normal of the glazing.

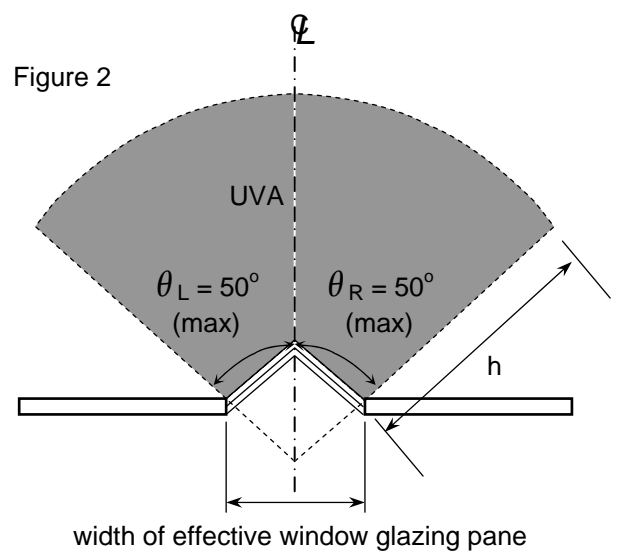
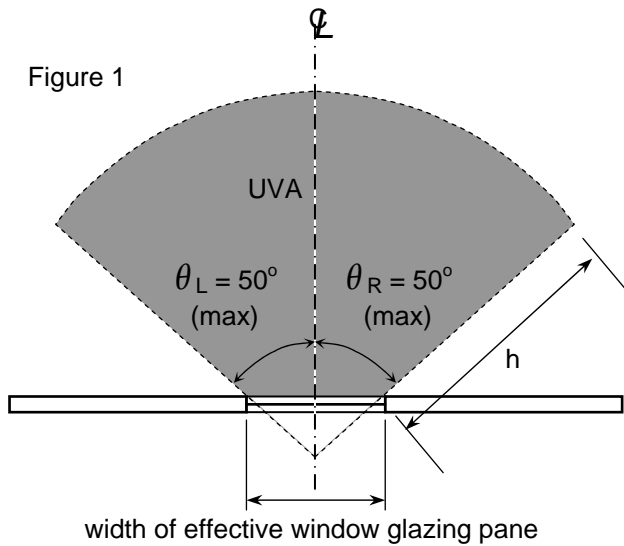
### Simplified, Performance-based Method

- c) The above physical phenomena could be simplified and two-dimensionally proportioned to an aggregated horizontal open area (UVA) in front of the window that effectively contributes to the daylight performance. The higher the height of facade is, the larger the UVA is required.
- d) Larger glazing area could also be accounted for scientifically in the calculation of UVA requirement to allow further design flexibility.

#### 4.3 The principles of the Unobstructed Vision Area Method are as follows:

- a) the unobstructed vision area of a window is the unobstructed area bounded by a cone with the horizontal angle measuring 100 degree up to both edges of the window glazing pane, symmetrical and perpendicular to the window plane (see Diagram A). For the purpose of measurement of the unobstructed vision area, the currently accepted amenity features including drying racks, small projecting air-conditioner platforms or hoods and window eaves protruding onto the unobstructed vision area may be disregarded if the size of these features is not excessive;
- b) the maximum length of the cone of the unobstructed vision area is equal to the height of facade in which the window is provided (see Diagram B);

Diagram A : Measurement of the cone of UVA from both edges of window pane



UVA = unobstructed vision area  
h = maximum length of the cone  
= height of facade  
 $\theta = \theta_L + \theta_R = 100^\circ$

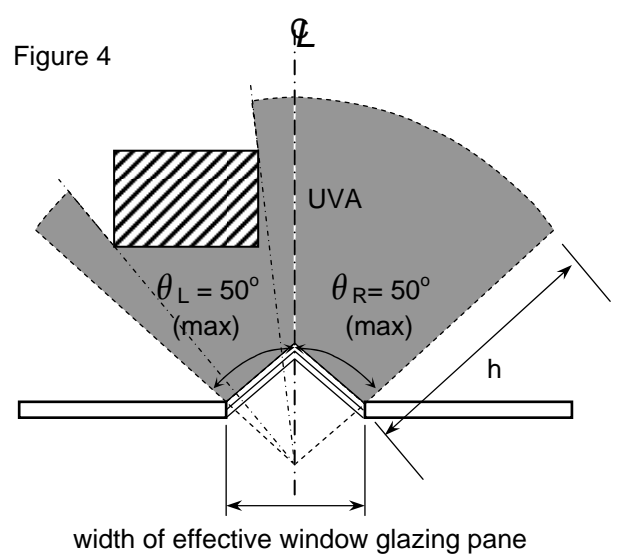
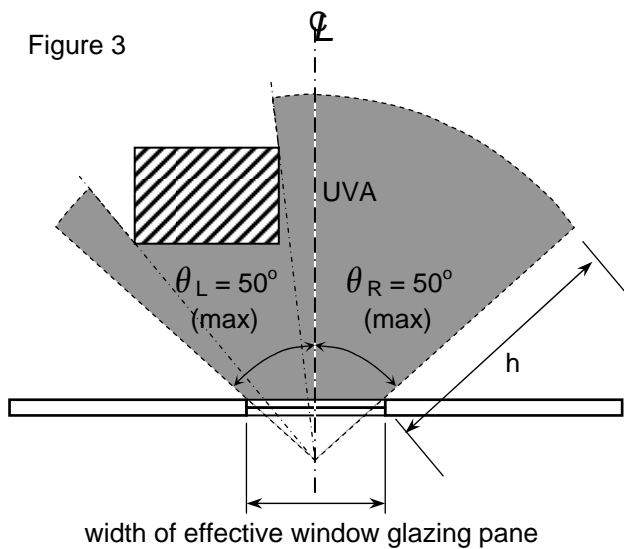
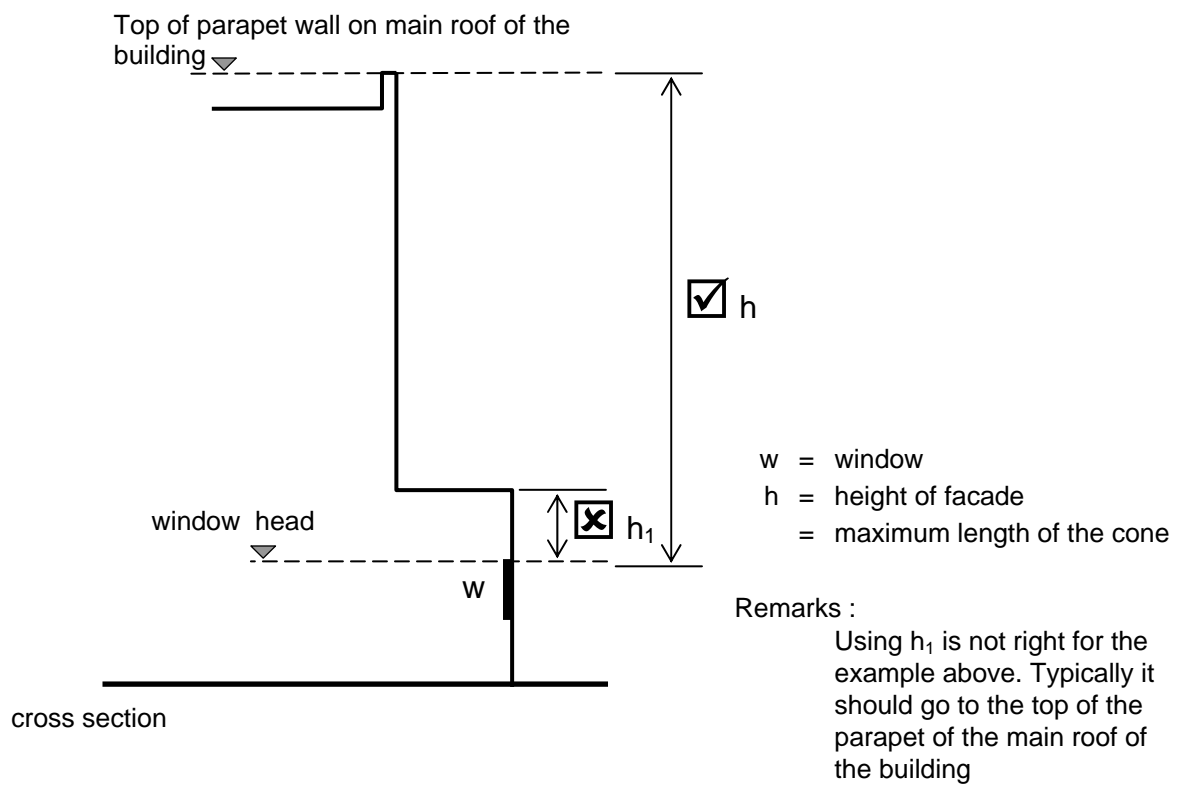
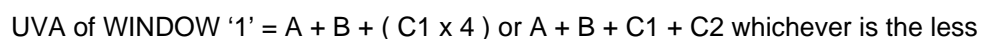


Figure 3 & 4 help to explain how the UVA is drawn when there is an obstruction

Diagram B : Measurement of height of facade and unobstructed vision area



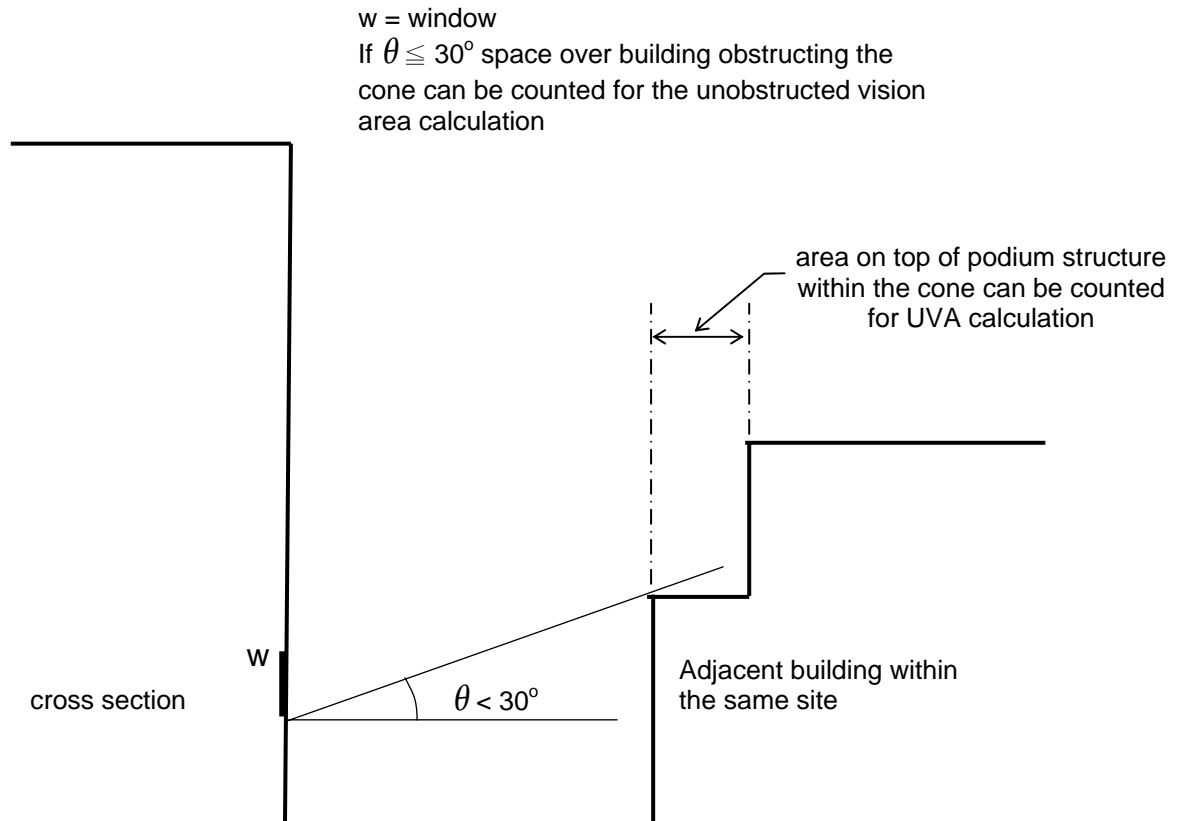
- Diagram C : Measurement of unobstructed vision area with the cone protruding beyond the site boundary





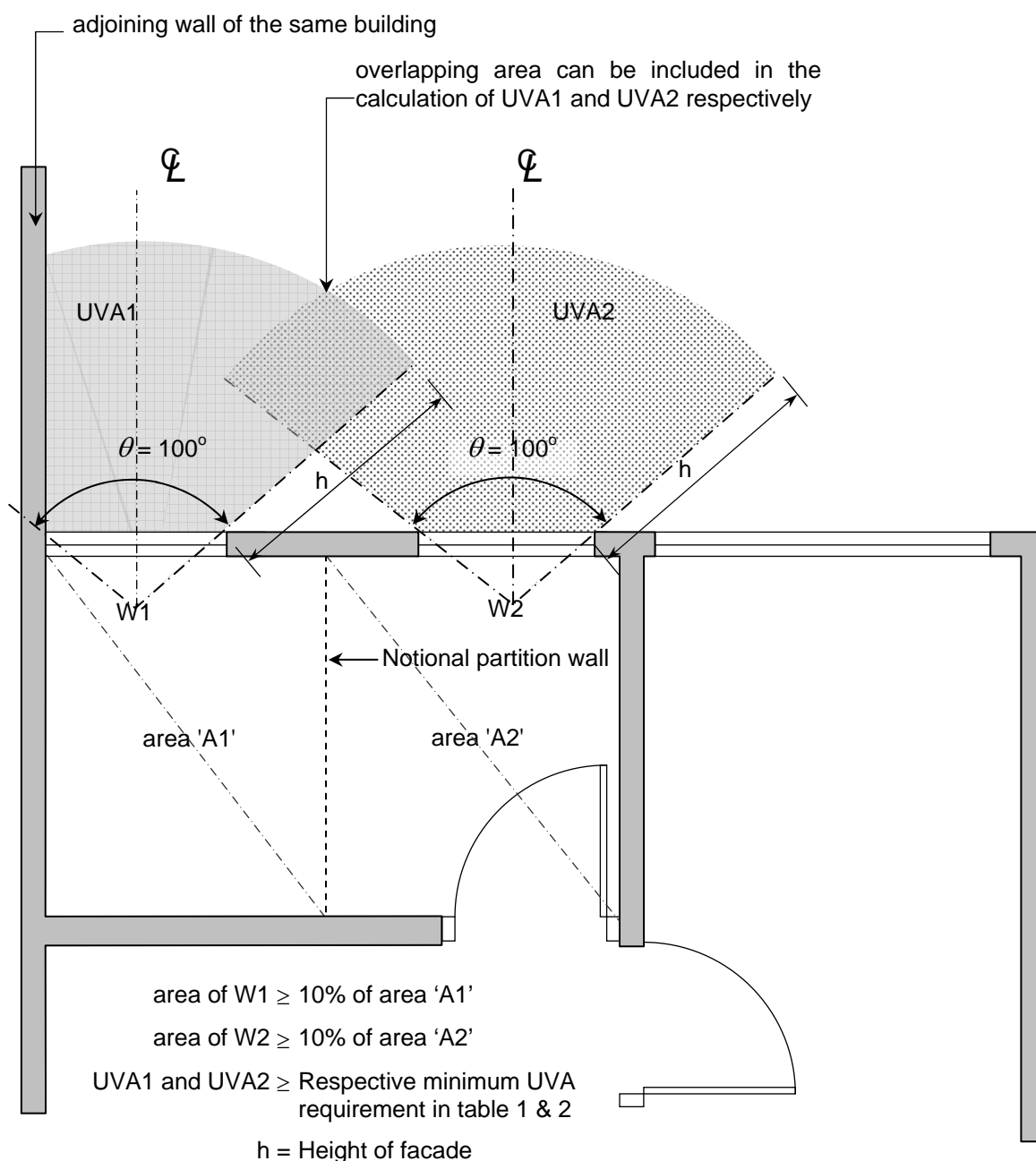
- e) where the highest point of the adjacent structure within the same site fronting the window does not sustain a vertical obstruction of more than 30 degree, the area on top of that structure within the cone may be counted for the calculation of the unobstructed vision area (see Diagram D); and

Diagram D : Measurement of unobstructed vision area on top of building obstructing the cone



- f) for a room requiring more than one window to comply with the minimum day-lighting requirement, the total room area can be considered as an amalgamation of subdivision rooms separated by notional partitions and each of which is provided with a window that satisfies the respective minimum day-lighting requirement corresponding to the area of each subdivision (see Diagram E).

Diagram E : Measurement of unobstructed vision area for a room requiring more than one window



4.4 No window in the building shall, for the purpose of paragraph 4.1, be counted for the calculation of unobstructed vision area unless-

- it faces into a space which is uncovered and not bounded on the side opposite the window by any obstruction of the building;
- the top of the window is at least 2m above the floor level; and
- the superficial area of glass in the window or the aggregate superficial area of glass in the windows (calculated from width of effective window glazing pane), as the case may be, shall not be less than 10% of the usable floor area of the room in which the window or windows are located.

- 4.5 Where the aggregate superficial area of glass in the window or windows (i.e. actual glazing area excluding window frames) is equal to 10%, 15% or 20% of the usable floor area of the room, the total unobstructed vision area shall not be less than the corresponding area shown in Table 1 and Table 2 according to respective use and the height of façade in which the window or windows is provided.

**Table 1 Unobstructed Vision Area Requirement for Habitable Room (8% VDF)**

Height of façade (m)	Minimum UVA (s.m.)		
	Glazing Area: 10% of UFA	Glazing Area: 15% of UFA	Glazing Area: 20% of UFA
10 or below	50	30	20
20	100	100	60
30	250	200	150
40	400	300	200
50	600	500	400
60	900	700	500
70	1,200	900	700
80	1,600	1,200	900
90	2,000	1,500	1,100
100	2,400	1,800	1,300
110	2,900	2,200	1,600
120	3,500	2,600	1,900
130	4,100	3,100	2,200
140	4,800	3,600	2,600
150	5,400	4,100	3,000
160	6,200	4,600	3,400
170	7,000	5,200	3,800
180	7,800	5,900	4,300
190	8,700	6,500	4,700
200 or above	9,600	7,200	5,200

**Table 2 Unobstructed Vision Area Requirement for Domestic Kitchen (4% VDF)**

Height of façade (m)	Minimum UVA (s.m.)		
	Glazing Area: 10% of UFA	Glazing Area: 15% of UFA	Glazing Area: 20% of UFA
10 or below	20	15	10
20	60	40	30
30	150	100	70
40	200	200	100
50	400	300	200
60	500	400	300
70	700	500	400
80	900	700	500
90	1,100	900	700
100	1,300	1,000	800
110	1,600	1,300	1,000
120	1,900	1,500	1,200
130	2,200	1,700	1,400
140	2,600	2,000	1,600
150	3,000	2,300	1,800
160	3,400	2,600	2,000
170	3,800	2,900	2,300
180	4,300	3,300	2,600
190	4,700	3,700	2,900
200 or above	5,200	4,000	3,200

Notes:

- (i) In the case of the height of façade lies within the ranges shown in the table, the unobstructed vision area should be derived from interpolation method.

- 4.6 Where the aggregate superficial area of glass in the window or windows lies within the range between 10% to 15% or 15% to 20% of the usable floor area of

the room, the Building Authority would accept interpolation of the area fallen within the range shown in Table 1 and Table 2 according to respective use. For the window area greater than 20% of the usable floor area of the room, the total unobstructed vision area shall not be less than the area required for 20% of the usable floor area of the room shown in Table 1 and Table 2, as the case may be.

### **PART III**

#### **5. Ventilation**

5.1 The BA would accept a room used for habitation or as a kitchen to have met the performance standard of ventilation if the following conditions are satisfied:-

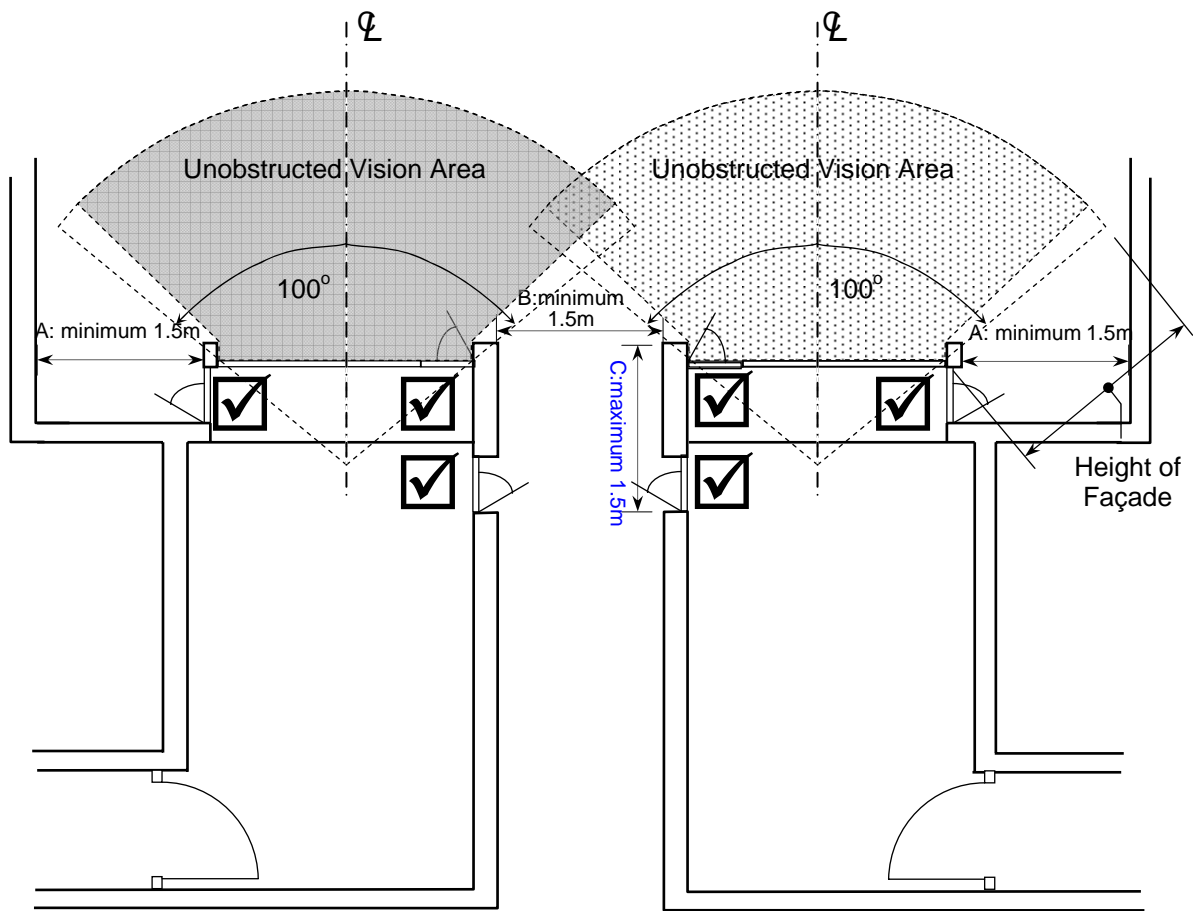
- a) The area of the primary opening(s) provided in the room is not less than one sixteenth of the usable floor area of the room;
- b) The primary opening(s) face into a clear and unobstructed area complying with at least the open air requirement; and
- c) in the case of kitchen, 5 ACH mechanical ventilation is provided in addition to the requirements in (a) and (b) above.

There are a number of assessment tools available in the market for assessment of the performance of ventilation in buildings such as Computational Fluid Dynamic (CFD) tools. Consideration for acceptance will be given if the validity and appropriateness of the tools are substantiated to the satisfaction of the BA.

5.2 For the purpose of assessing the sizes of the primary and secondary openings for ventilation, the effective area of the primary and secondary openings, irrespective of the height of the window head and window sill is counted.

### 5.3 The arrangement of window openings is illustrated in Diagram F

Diagram F : Openable window for ventilation



☑ = accountable as primary opening(s)

- aggregate size shall not be less than one-sixteenth of the usable floor area of the room

A : Minimum distance of a corner window from the external wall should be 1.5m

B : Minimum distance of a window from opposite external wall should be 1.5m

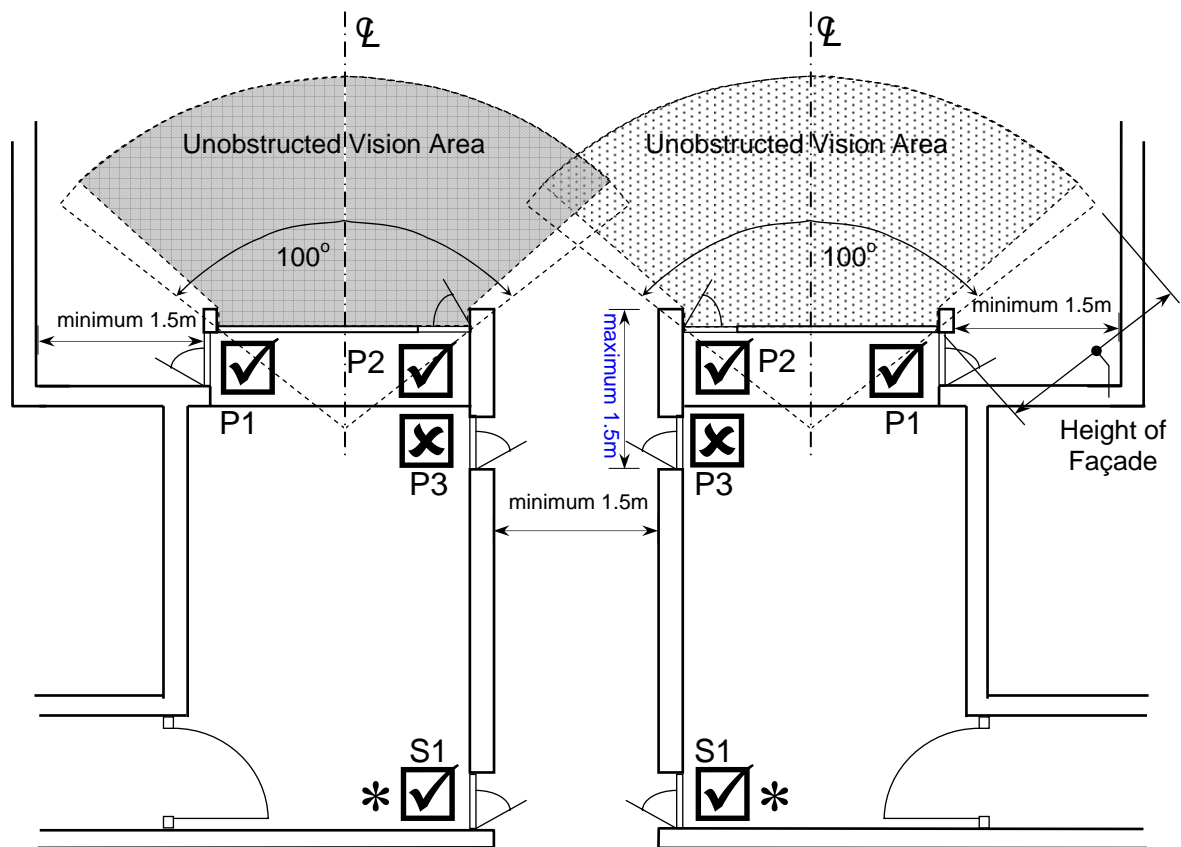
C : Maximum distance of any part of window should not be larger than 1.5m from end of the external wall

## 6. Cross Ventilation

6.1 Where cross ventilation is provided, the requirements on the openable area of the window and the restriction as set out in B(P)Reg. 32 on the depth of the room are relaxed as follows (see Diagram G):-

- the aggregate size of the primary opening(s) shall not be less than 2% of the usable floor area of the room;
- the aggregate size of the secondary opening(s) shall not be less than 2% of the usable floor area of the room; and
- the depth of the room from the primary opening may be extended to a maximum of 12 m.

Diagram G : Openable window for ventilation when cross-ventilation is provided



☑ = accountable as primary or secondary opening

☒ = not accountable as primary opening for the purpose of cross ventilation.

\* = secondary opening(s) in rear half of the room accepted for the purpose of cross ventilation only when the primary opening(s) is not located on the same plane of the secondary opening(s).

- the respective aggregate sizes of the primary and secondary openings shall not be less than 2% of the usable floor area of the room.

## **GUIDANCE NOTES ON VALIDATION OF LIGHTING SIMULATION SOFTWARE**

### **1. Introduction**

These notes give guidance on the validation of lighting simulation software for assessing the performance of natural lighting in buildings. As computational lighting simulation is a complicated science, APs may wish to consult a specialist in lighting design.

### **2. Computational Lighting Simulation**

2.1 The BA accepts computational lighting simulation for the assessment of the performance of natural lighting in buildings. The BA will accept such a proposal provided that the software is validated and the simulation is properly conducted. For avoidance of doubt, the currently accepted amenity features including drying racks, small projecting air-conditioner platforms or hoods and window eaves protruding onto the unobstructed vision area may be disregarded if the size of these features is not excessive.

2.2 APs should attend to the following 4 important criteria in carrying out a lighting simulation test:

- (i) The accuracy of the Global Illumination Model of the software, which determines how well the software cater for the characteristics of the sky.
- (ii) The accuracy of the Local Illumination Model of the software, which determines how well the software cater for inter-reflections between objects in the model.
- (iii) The accuracy of the Geometric description of the simulated scenes, which requires the geometric input to the simulation software, is representative of the scenes to be test.
- (iv) The accuracy of the Material description of the simulated scenes, which requires the material reflectance of the surfaces of the geometry, is appropriately set.

### **3. Approach of Validation – Standard 3D Model and Datum**

- 3.1 For the purpose of validating the software, a Standard 3D model is built as the geometrical input of the test and 62 selected points are defined on the model, which together form the Datum of the validation test. Details of the assembly are provided at Annex 1. An overview of the Standard 3D model and the distribution of Datum points on the Standard 3D model are at Figure 1 and Figure 2 of Annex 1 respectively.
- 3.2 Up to 2 different materials reflectance may be set, one for ALL vertical surfaces and another for ALL horizontal surfaces. Alternatively, a single setting of reflectance may be used for all surfaces. As part of the submission, the material reflectance(s) set should be reported.
- 3.3 There are total 62 points (23 on horizontal surfaces and 39 on vertical surfaces) where the simulated results of the Standard 3D model should be reported and compared with the Datum. Using the software to be validated with particular settings, the results of all the 62 points on the Standard 3D model must not be more than the Datum. Simulated results of the Daylight Factor (DF) and Vertical Daylight Factor (VDF) of say 12.459% could be rounded off to whole number (i.e.12%). Likewise, 12.501% should be rounded off to 13%. Details of the Datum values are provided at Annex 2.

### **4. Validation Test**

To demonstrate that the software is validated for use, the APs should submit the following document to BA for approval:

- (i) The name and version of the software to be validated. The name, country of origin and contact details of the vendor including mail address, telephone number, fax number, email and website address must be attached.
- (ii) A folder containing the generic simulation file(s) with the 3D model, and all files and detail settings necessary to reproduce the simulation results independently and without making reference to the APs.
- (iii) A note stating the Material Reflectance of the Standard 3D model used. Only up to 2 material reflectance settings may be used: one for the ground horizontal surface, the other for all vertical surfaces.



- (iv) A print out of DF and VDF of ALL 62 points as defined in The Datum that are generated by the software to be validated. And a statement that the 62 values obtained with the software to be validated, using the settings and geometry as defined, is UNDER the respective values of the Datum.

## **5.0 Guide on creating an Accurate Geometric Model**

5.1 Once the software is validated for use, the AP should ensure the accurate building of the geometry file of the design. An example is shown in Annex 3. Apart from the building to be tested, the surrounding wall should be constructed according to the following guidelines (refer to Annex 3 for reference):-

- (i) The building to be tested and all buildings within the same site must be accurately modeled.
- (ii) A “closed” surrounding wall is to be built surrounding the site, in such a way that no gap is possible. This surrounding wall should be made up of two parts: from ground to height W and from height W to height H. This wall is to represent reasonably the surrounding conditions of the test site.
- (iii) Height W is the equivalent height of the façade area of all immediate buildings when compressed to fill the entire length of the site boundary. The surrounding wall up to this height W is solid. This portion of the wall represents the main bulk of the buildings on the test site.
- (iv) Height H will be the average height of buildings used to work out height W. The wall between W and H should be perforated with slots. Vertical slots equal to 1/5 (or 20%) the area of the surrounding wall W to H may be inserted. The void portions of the slots are to be between 10 to 15 meters wide – exact dimension to be worked out evenly across the boundary. The slotted wall represents closely the cityscape immediately in front and beyond the test site. This portion of the wall captures the gaps of tower buildings around the site.
- (v) The minimum perpendicular dimension from own site boundary to the edge of all the ‘immediate tower blocks’ facing the same boundary on its own site should be defined. Assume the average dimension be A meter. For example, if there are 3 immediate tower blocks, A will be the average of their minimum distance from the boundary. The minimum distance should be taken from the walls of the buildings.

(vi) The surrounding wall towards that boundary could be positioned A into the neighbour's boundary. This literally assumes that if the test building is set back from its own site boundary, a mutually respected situation could be established from the surrounding buildings on the other side of the boundary.

(vii) The design could also take advantage of 'long and straight' roads leading out of the test site. The open end of roads leading out could be capped (closed) reasonably at a distance 5 times the height of the surrounding walls.

5.2 The surrounding walls proposed here is a simplified method to re-create reasonable surroundings for the test site. The heights and positions of the surrounding wall facing various orientations of the test site are to be determined independently.

## **6.0 Guide on Material Description**

The AP should use the reflectance they had set when the software was originally validated for the scene they are going to test. Only 2 reflectance should be used, one for all ground horizontal surfaces and another for all building vertical surfaces including the top horizontal surfaces of any podium.

## **7.0 Performance Standard for Natural Lighting**

7.1 No window in a building shall be take into account unless:

- (a) it faces into a space which is uncovered and not bounded on the side opposite the window by any obstruction of the building; and
- (b) the top of the window is at least 2m above the floor level.

7.2 Under PNAP 278, 8% VDF and 4% VDF should be made available on the vertical surface of the windows of habitable room and kitchen respectively when the aggregate superficial area of glass in a window (i.e. actual glazing area excluding window frames) is 10% of the usable floor area of the room. If larger window size is used, the following table could be used for the purpose of simulation:

<b>Required VDF</b>  <b>Glazing area (% of UFA)</b>	<b>VDF 8% or more</b>	<b>VDF 6% or more</b>	<b>VDF 5% or more</b>	<b>VDF 4% or more</b>	<b>VDF 3% or more</b>
Habitable room	10%	15%	20%		
Kitchen				10%	15%

7.3 The maximum glazing area is limited to 20% and 15% for habitable room and kitchen respectively. Therefore, for example, VDF of habitable room cannot be less than 5%. Extrapolation beyond the limit (VDF 5% for habitable room or VDF 3% for kitchen) is not possible.

7.4 The required glazing area could be interpolated from the table. For example, the simulation results show that the window is receiving 7.5% VDF. The glazing area needed is therefore 11.25% or larger.

## 8.0 Daylight Software

Some software are currently available in the market for daylight studies. Details are provided at Annex 4 for reference.

**The Standard 3D Model**

1. The Standard 3D model is assembled with 1 unit by 1 unit cube. It is therefore 34 units wide, 44 units high and 8 units deep.

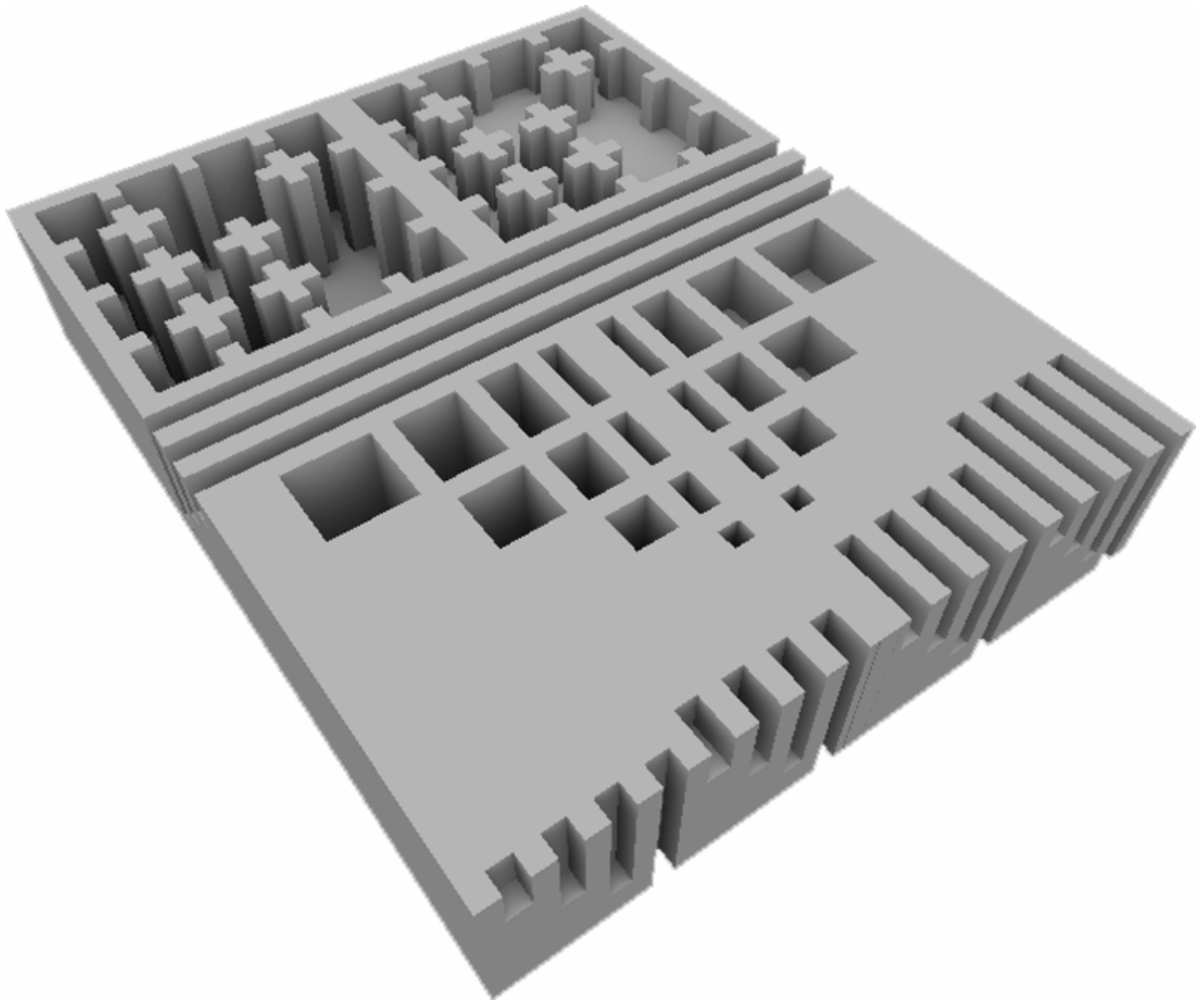


Figure 1: An overview of the Standard 3D model

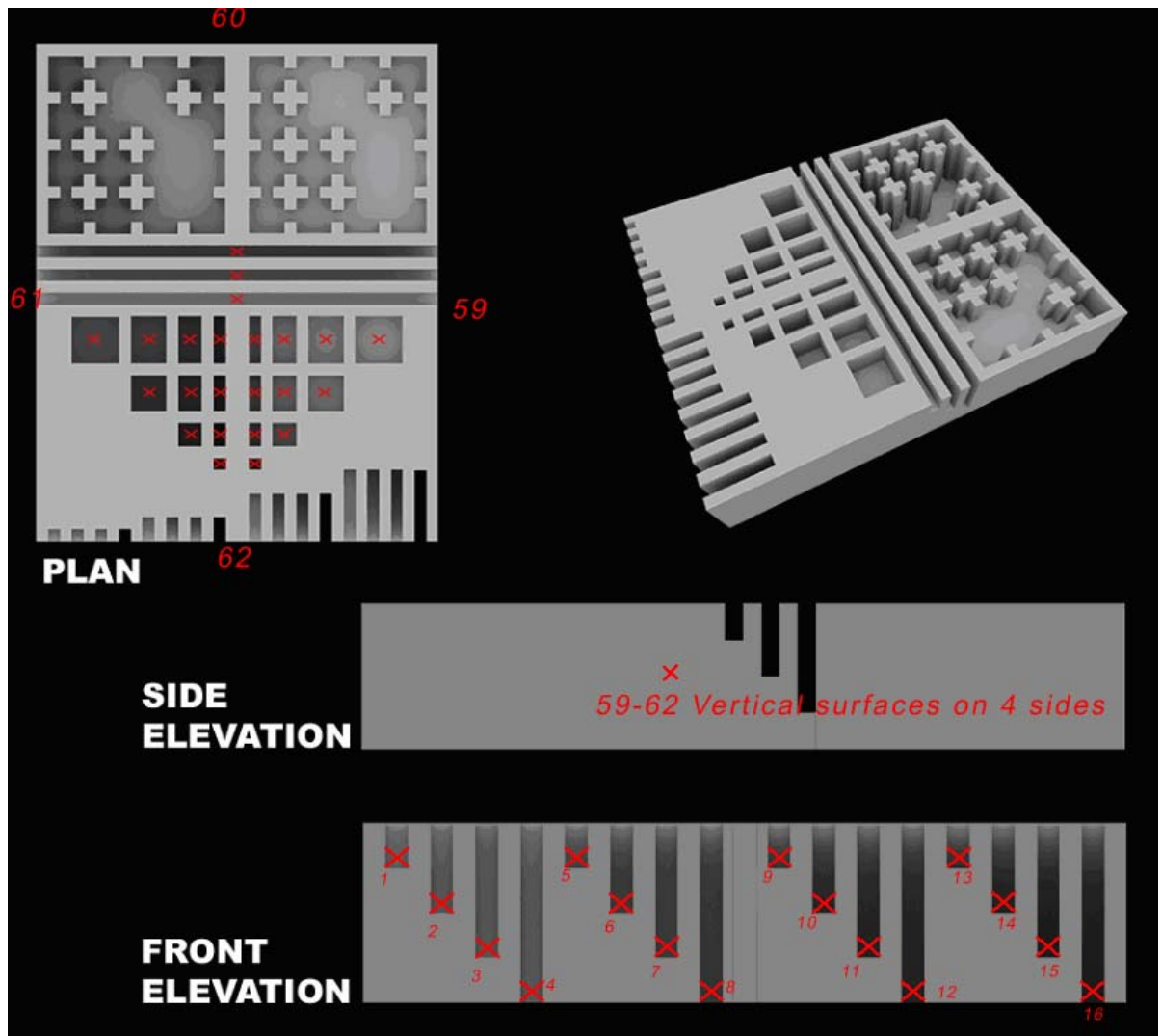
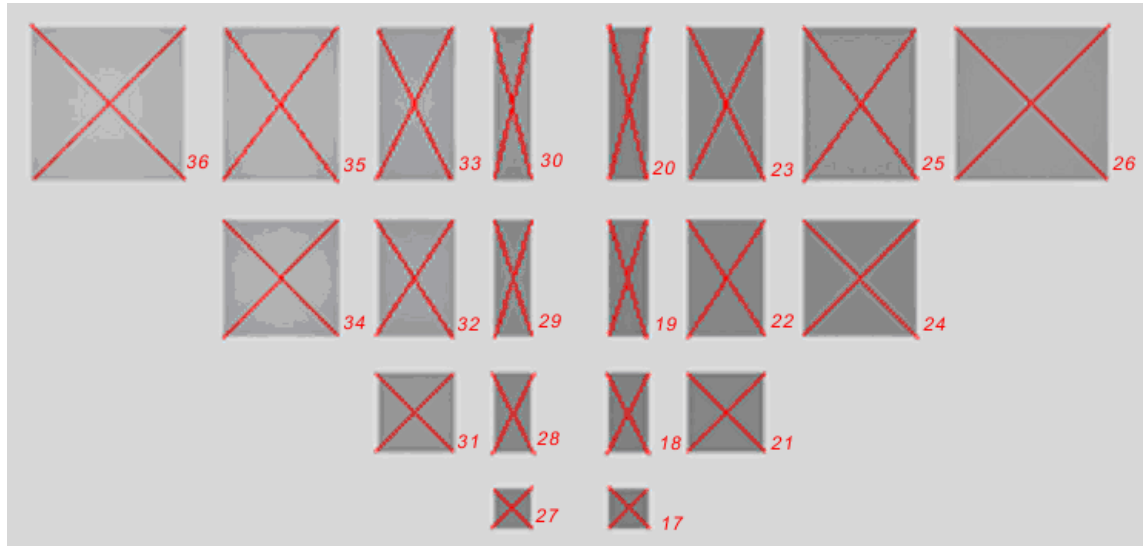


Figure 2: Distribution of Datum points on the Standard 3D model

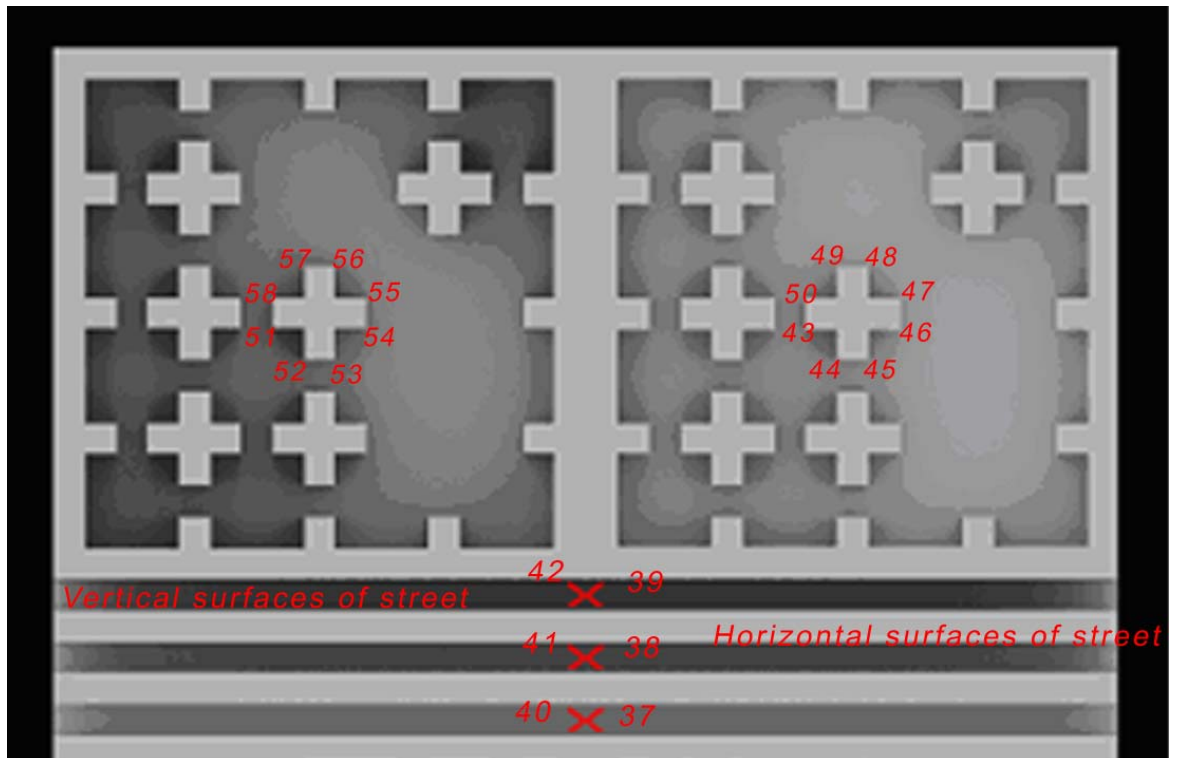
2. Figure 2 shows distribution of datum points on the Standard 3D model:
  - (i) Datum points 1-16: Within it there are 16 slots at the bottom (Front Elevation in Figure 2). They are 1 unit wide, 2, 4, 6 and 8 units high, and 2, 4, 6 and 8 units deep. -The 4 deepest slots (8 unit deep) puncture the base of the overall model and thus could be seen from below.



Holes of the Standard 3D model

Figure 3

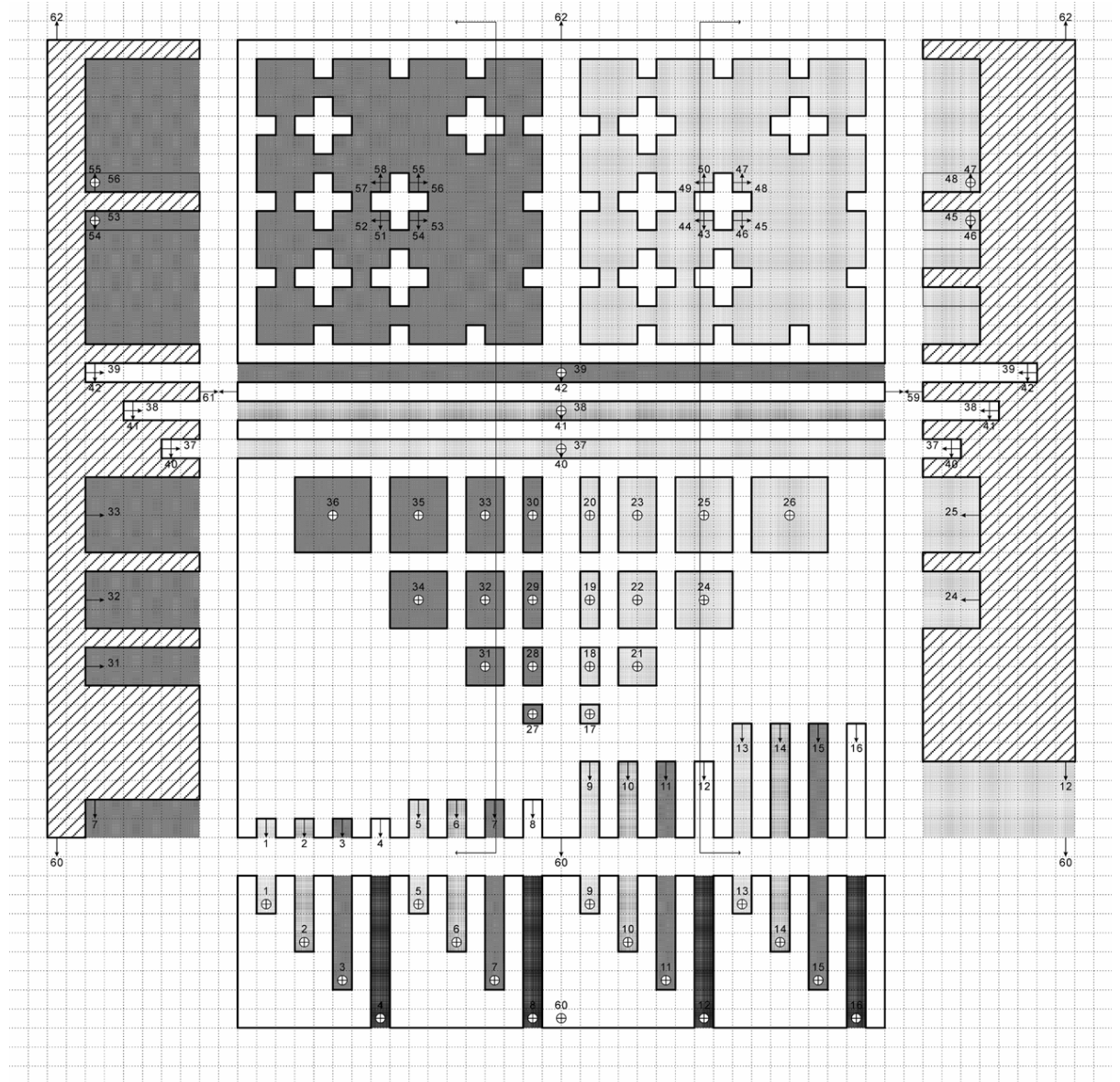
- (ii) Datum points 17-36: On top of the slots, there are 20 holes (Figure 3 refers). The holes on the right are 3 units deep, whilst the ones on the left are 6 units deep. The largest hole is 4x4 unit in size, whilst the smallest hole is 1x1 unit in size. The rest of the holes follow the logic ranging from 1x1 to 1x4, and 1x4 to 4x4.



Streets and Buildings of the Standard 3D model

Figure 4

- (iii) Datum points 37-42: There are three horizontal slots on top of the holes (Figure 4 refers). They represent street conditions. They are all 1 unit high, and 2, 4 and 6 unit deep respectively.
  - (iv) Datum points 43-58: On top of the slots are 2 housing layouts (Figure 4 refers). The one on the right is 3 units deep, and the one on the left is 6 units deep. The cruciform blocks are all 1+1+1 unit in plan.
  - (v) Datum points 59-62: The four vertical external surfaces of the model (Plan and Side Elevation in Figure 2).
3. The Standard 3D should ideally have all the surfaces join perfectly (that is to say, there is no gap between the surfaces used to build the model). Typically the use of solid model is the best way to guarantee that. If surface CAD modeler is used (e.g. AutoCAD), the operator must exercise extra care in building the model. The reason for perfectly aligned model is to prevent light leak through the gaps. Moreover, some software is known to behave strangely when surfaces intercept each other.
  4. The plan, sections and elevations of the Standard 3D model is shown in Figure 5.



Plan and Sections and elevation of the Standard 3D model  
Figure 5



### **The Datum**

The Datum values are shown in the following table:

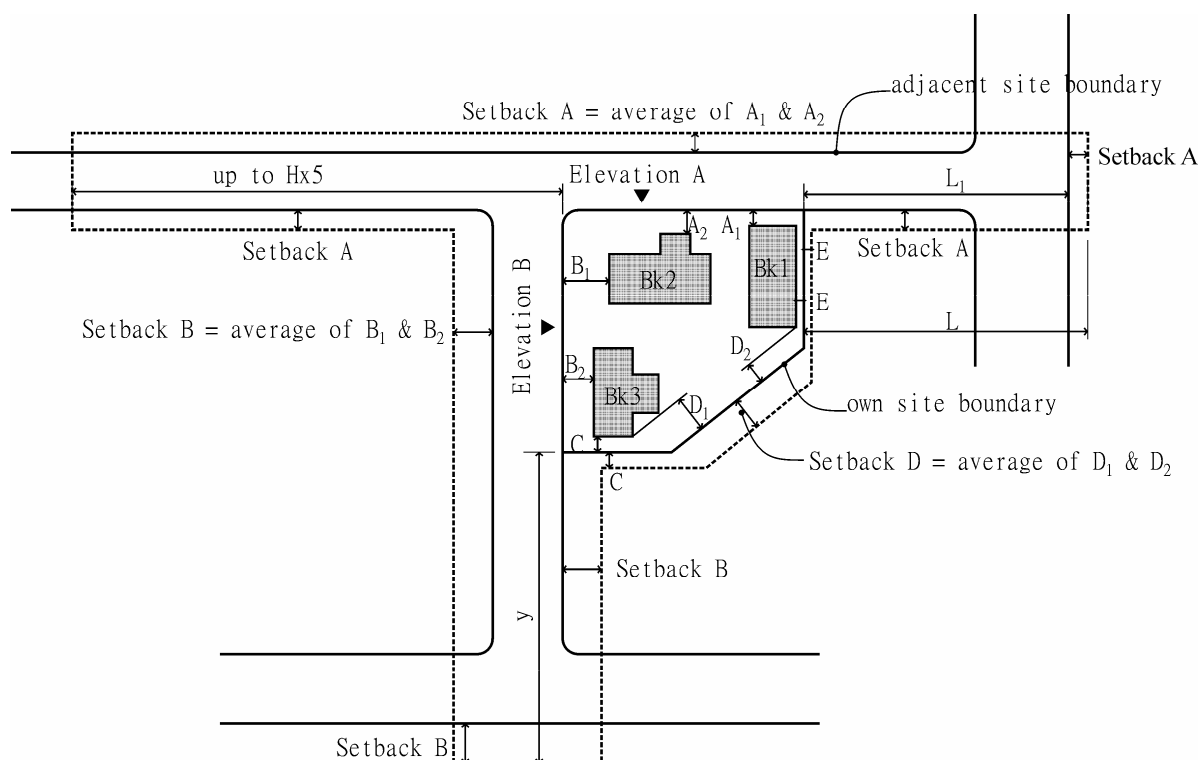
Datum point	Key description	Detail description	DF or VDF	<b>Datum (%)</b>
1	Slot	1x1x 2 deep	VDF	<b>22</b>
2		1x1x 4 deep	VDF	<b>21</b>
3		1x1x 6 deep	VDF	<b>21</b>
4		1x1x 8 deep	VDF	<b>20</b>
5	Slot	1x2x 2 deep	VDF	<b>14</b>
6		1x2x 4 deep	VDF	<b>12</b>
7		1x2x 6 deep	VDF	<b>12</b>
8		1x2x 8 deep	VDF	<b>11</b>
9	Slot	1x4x 2 deep	VDF	<b>12</b>
10		1x4x 4 deep	VDF	<b>8</b>
11		1x4x 6 deep	VDF	<b>8</b>
12		1x4x 8 deep	VDF	<b>7</b>
13	Slot	1x6x 2 deep	VDF	<b>10</b>
14		1x6x 4 deep	VDF	<b>6</b>
15		1x6x 6 deep	VDF	<b>5</b>
16		1x6x 8 deep	VDF	<b>5</b>
17	Hole	1x1x3 deep	DF	<b>6</b>
18		1x2x3 deep	DF	<b>10</b>
19		1x3x3 deep	DF	<b>13</b>
20		1x4x3 deep	DF	<b>15</b>
21		2x2x3 deep	DF	<b>18</b>
22		2x3x3 deep	DF	<b>24</b>
23		2x4x3 deep	DF	<b>28</b>
24		3x3x3 deep	DF	<b>32</b>
25		3x4x3 deep	DF	<b>38</b>
26		4x4x3 deep	DF	<b>45</b>
27	Hole	1x1x6 deep	DF	<b>2</b>
28		1x2x6 deep	DF	<b>4</b>
29		1x3x6 deep	DF	<b>5</b>
30		1x4x6 deep	DF	<b>6</b>
31		2x2x6 deep	DF	<b>7</b>

32		2x3x6 deep	DF	<b>8</b>
33		2x4x6 deep	DF	<b>10</b>
34		3x3x6 deep	DF	<b>11</b>
35		3x4x6 deep	DF	<b>14</b>
36		4x4x6 deep	DF	<b>18</b>
37	Middle of Street	1x2 deep	DF	<b>30</b>
38		1x4 deep	DF	<b>16</b>
39		1x6 deep	DF	<b>11</b>
40		1x2 deep	VDF	<b>10</b>
41		1x4 deep	VDF	<b>4</b>
42		1x6 deep	VDF	<b>2</b>
43	Building	Surface 1 x 3 deep (H facing 3 blks)	VDF	<b>13</b>
44	(anti- clockwise)	Surface 2 x 3 deep (V facing 3 blks)	VDF	<b>13</b>
45		Surface 3 x 3 deep	VDF	<b>22</b>
46		Surface 4 x 3 deep	VDF	<b>20</b>
47		Surface 5 x 3 deep	VDF	<b>18</b>
48		Surface 6 x 3 deep	VDF	<b>19</b>
49		Surface 7 x 3 deep	VDF	<b>14</b>
50		Surface 8 x 3 deep	VDF	<b>19</b>
51	Building	Surface 1 x 6 deep (H facing 3 blks)	VDF	<b>5</b>
52	(anti-clockwise)	Surface 2 x 6 deep (V facing 3 blks)	VDF	<b>5</b>
53		Surface 3 x 6 deep	VDF	<b>12</b>
54		Surface 4 x 6 deep	VDF	<b>8</b>
55		Surface 5 x 6 deep	VDF	<b>9</b>
56		Surface 6 x 6 deep	VDF	<b>9</b>
57		Surface 7 x 6 deep	VDF	<b>5</b>
58		Surface 8 x 6 deep	VDF	<b>9</b>
59	External surfaces	Surface 1	VDF	<b>40</b>
60		Surface 2	VDF	<b>40</b>
61		Surface 3	VDF	<b>40</b>
62		Surface 4	VDF	<b>40</b>

Note :    DF – Daylight Factor  
               VDF – Vertical Daylight Factor

### Geometric Model – Example to illustrate the construction of surrounding walls

To determine the position of the surrounding walls of the test site

**Setback of surrounding wall** (example for elevation A)

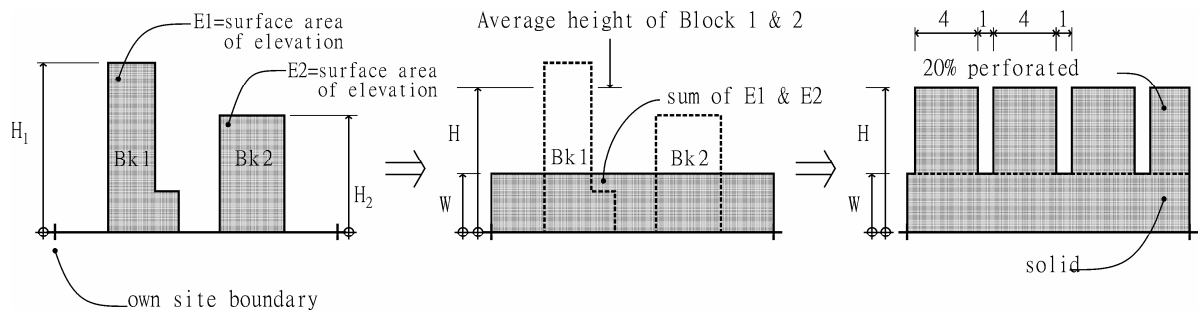
- Factor A<sub>1</sub> = setback of tower block 1
- Factor A<sub>2</sub> = setback of tower block 2
- Setback A = average of A<sub>1</sub> + A<sub>2</sub>

**Extent of surrounding wall to close the street** (example for elevation A)

- Factor  $H_1$  = height of tower block 1 from street level
- Factor  $H_2$  = height of tower block 2 from street level
- Factor  $H$  = average of  $H_1$  &  $H_2$
- Factor  $L_1$  = actual distance from site to cross road
- Extent  $L$  =  $L_1$  + setback A, or  $H \times 5$ , whichever the less

Figure 1: The Setting Out of Surrounding Walls

To determine the heights of the surrounding walls facing the boundary of the test site



### Base of surrounding wall (example for elevation A)

- Height of Podium  $W$  = sum of area of elevation of Block 1 and Block 2 divided by width of site
- Height of perforated wall  $H$  = average of  $H_1$  &  $H_2$

Figure 2: The Height of surrounding walls (Elevation A)

**(Left)** Looking at the test site from a certain direction parallel to the boundary, two immediate buildings (including their podiums) are to be taken into account.

**(Middle)** The elevation areas of the buildings (area of Block 1 and area of Block 2), calculated parallel to the boundary, will be summed. This total area will form the height ( $W$ ) of an equivalent sized rectangle occupying the whole length of the test site facing that boundary. This represents the 'solid' base of the surrounding walls facing that direction of the boundary. Height  $W_1$ ,  $W_2$ ,  $W_3$  and so on for walls facing other directions of the test boundary could be similarly worked out.

**(Right)** On top of this solid wall should be placed a "slotted wall". This represents possible light from gaps between tower buildings. The slot wall has a rhythm of 1:4:1:4 and so on. When scaled to real dimension, the void portion of the wall should be between 10 to 15 meters. The exact dimension will be worked out evenly across that portion of the boundary. The total height of this wall ( $W+H$ ) is equal to the average height of the two immediate buildings used to work out  $H$  just now.

## **Daylight Software**

Some of the currently available software in the market for daylight studies are listed below for reference. For avoidance of doubt, their accuracy should be verified and the software should be validated before adapted for simulation.

### **ADELINE**

Daylighting, lighting, commercial buildings

### **AG123**

Lighting, daylighting, rendering, roadway

### **BSim2002**

Building simulation, energy, daylight, thermal analysis, indoor climate

### **Building Design Advisor**

Design, daylighting, energy performance, prototypes, case studies, commercial buildings

### **DAYSIM**

Annual daylight simulations, electric lighting energy use, lighting controls

### **Ecotect**

Environmental design, environmental analysis, conceptual design, validation; solar control, overshadowing, thermal design and analysis, heating and cooling loads, prevailing winds, natural and artificial lighting, life cycle assessment, life cycle costing, scheduling, geometric and statistical acoustic analysis

### **FLUCS**

Illumination, daylighting

### **LESODIAL**

Daylighting, early design stage, user-friendliness

### **Lightscape**

Daylighting, luminance

### **LumenMicro**

Daylighting, lighting, solar design, luminaries

### **RADIANCE**

Lighting, daylighting, rendering

### **SKYVISION**

Skylight, light well, fenestration, glazing, optical characteristics, daylighting.

### **SuperLite**

Daylighting, lighting, residential and commercial buildings

### **The Lightswitch Wizard**

Annual daylight simulations, electric lighting energy use, lighting controls

(6/2005)