# PROJECT TAK BO GARDEN

## FOR BETTER LIVING

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# GENERAL SITUATION

TAK BO GARDEN is a residential project finished in 1984 and located in Kowloon Bay Hong Kong. The area was formerly known as Ngau Tau Kok Industrial Area. Now many factories have been replaced with private and public estates, such as Telford Garden, Amoy Garden, Kai Yip Estate Choi Ying Estate and Lower Ngau Tau Kok Estate ect. This area was historically high densely built. and the well known serious outbreak of SARS happened in Amoy Garden 2003 and a fatal underground explosion occurred in 2006, both disasters occurred in pat due to the high density of the buildings and poor ventilation system within.

The Community of Tak Bo Garden:

1. Community Name: Tak Bo Garden
2. Location: Ngau Tau Kok Road3-5
3. Details:

Block A-D 40 floors, (1st ~5th floors for underground car parking and shops, 6th ~ 40th floors for residence.)

Block E-H 33 floors, (1st ~5th floors for car parking and shops, 6th ~ 40th floors for residence)

Each block has 8 units on each floor and total number is 2,016 units.


google earth map for this area

residential buildings in this area

residential buildings in this area

# WHAT TO DO AND HOW TO DO IT

Hong Kong has a hot and humid climate, so ventilation should be put into consideration during design process. Like other residence communities in this area, Tak Bo Garden is high densely built, serious self blocking is found, which greatly affects the utilization of daylight. These are the two design issues for the Project Tak Bo Garden regarding energy performance.

1 Conduct an on-site study. Focus on daylight problem and natural ventilation in this block, find out what they have and what the problems are. Pick 1 or 2 units located in relative lower floors as samples to get some data for further understanding.

2 After on-site investigation, software can be used to do simulation of the area to know what is happening there, more general data can be gained.

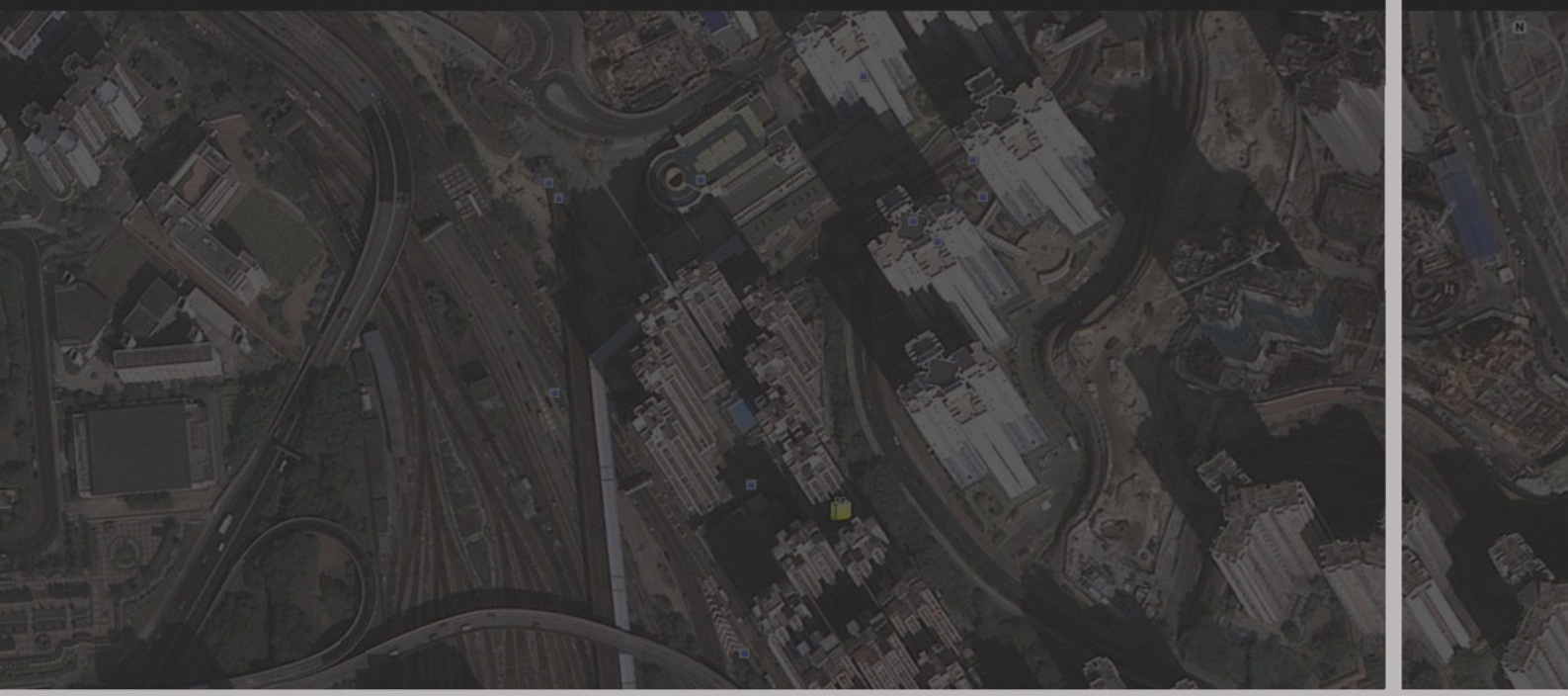
3 Based on all the data that can be collected, recognize the design issues, and work out a simple and initial strategy on planning and/or unit design.

picture for Tak Bo

picture for Tak Bo

picture for Tak Bo

# ON-SITE STUDY



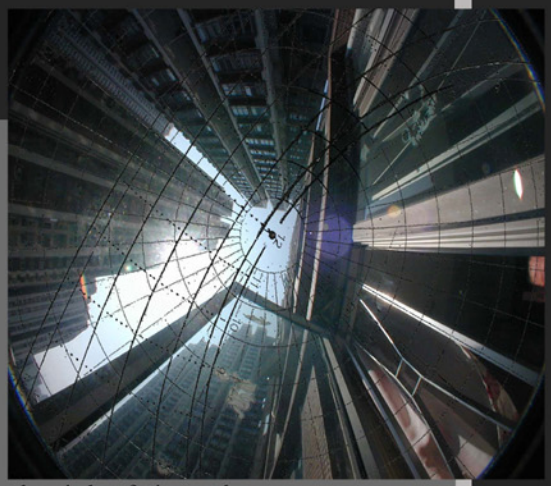
# ON-SITE STUDY___ CASE ONE

*Tak Bo Garden Block D Unit 6, 6th Floor*

For the window facing the garden (southeast orientation), there are 885 hours per year that can receive sunlight, 3360 hours per year that the sun is blocked by the blocks in Tak Bo while the other 375 hours is blocked by buildings outside the community. Namely 90% is self blocking. Need to point out that in winter (December), this window cannot receive any sunshine at all.

Using the same window for sky component and vertical daylight factor calculations, there are 44dots which are in the sky area(S), and about 160 dots in a fairly dark area (D). So quoting the equation Vertical Daylight Factor equals to [S + (198 * 2 - S – D) * 0.2] *0.2%, the VDF for this particular window is 17% (9% SC + 8% ERC). Another lateral window in this house has a VDF of 11% (2% SC + 9% ERC).

While the illuminance for an unblocked outdoor space was 6,300lx, the illuminance of the indoor space near the window was about 1,300lx and 53lx in front of the back wall. The house had little furniture and the decoration was relatively in dark color.

the window facing garden

the window facing garden

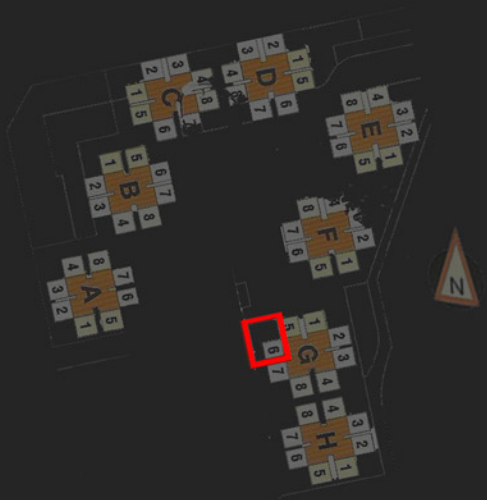
lateral window

# ON-SITE STUDY___ CASE TWO

*Tak Bo Garden Block G Unite 6, 8th Floor*

For the main window in the living room facing Ngau Tau Kok Road (southwest orientation), this window can receive sunlight without being blocked by other buildings 1590 hours in one year. Blocks A, B, and C are located on the west side of this building, and prevent strong sunshine striking the window on summer afternoons, which can greatly reduce the increase of the indoor temperature. It has almost 4.5 hours of sunshine after noon per day in December, and this should be welcomed in a low temperature condition but might cause over-heat in mild winters. In Hong Kong the winter sun is at 45°azimuth, so for thermal aspect, this window is an ideal one, facing south to welcome a low azimuth sun and with some obstructions on its southwest to exclude the intense sunshine on the summer afternoon.

For the same unit, the lateral window facing the inner garden has a different situation. Sun shine hours total 453 in one year. The sun is seriously blocked during the whole year and all caused by self blocking. We can see how the narrow distance between buildings affects the residences. And this window has a VDF value of 9.9% (3.4% SC + 6.5% ERC).

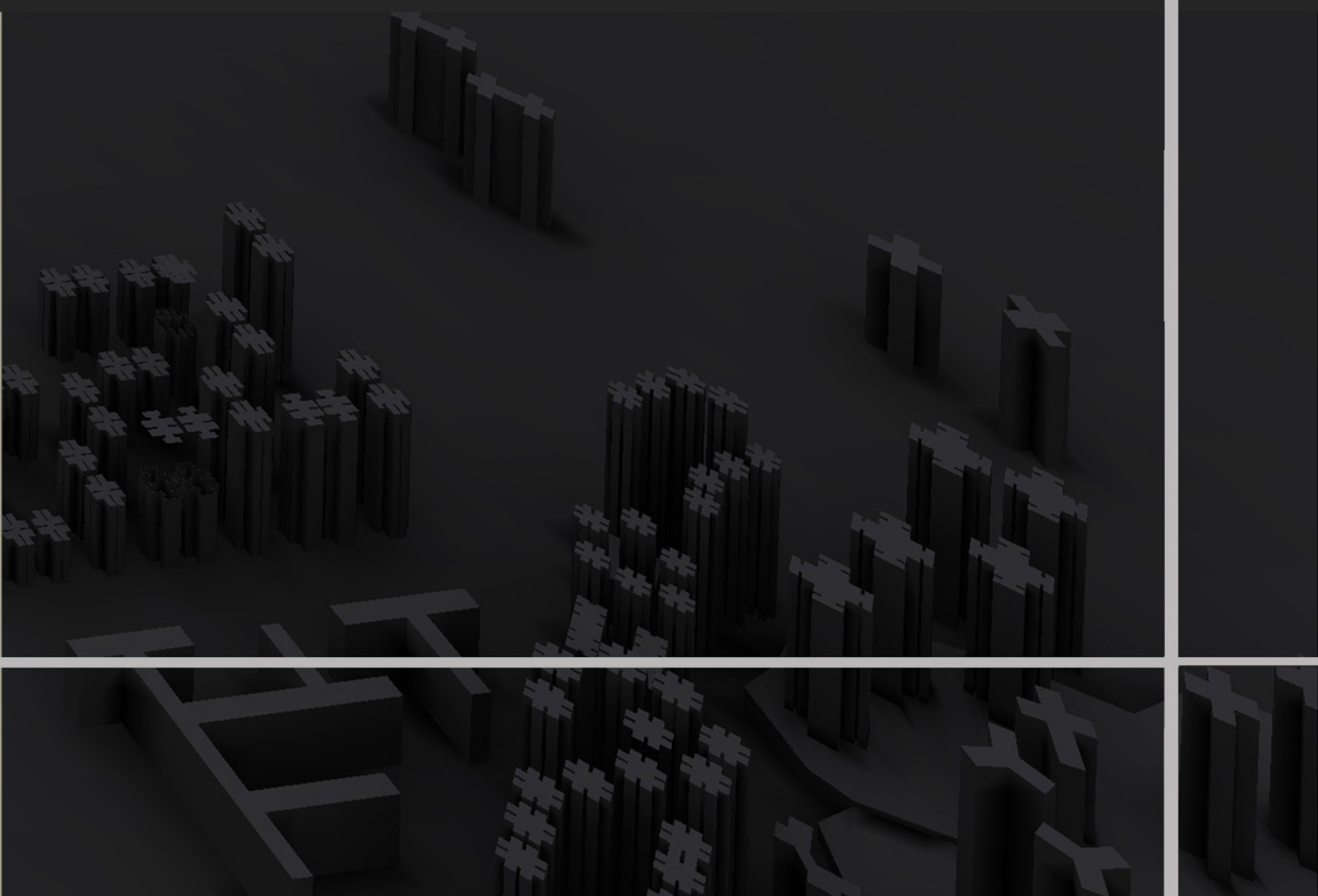



window facing Ngau Tau Kok Road

lateral window facing inner garden

lateral window facing inner garden

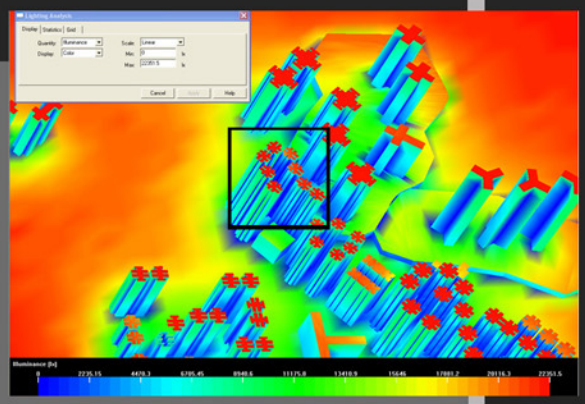
# SUMILATION AND ANALYSIS

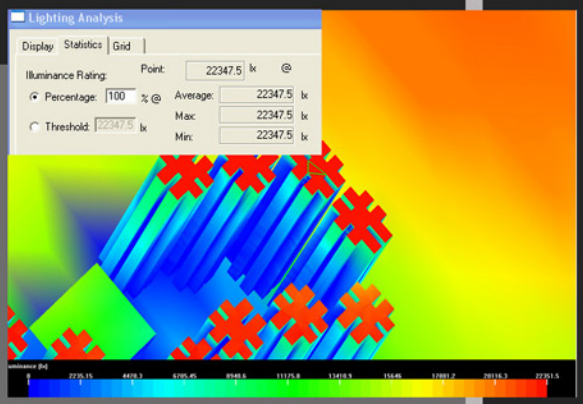


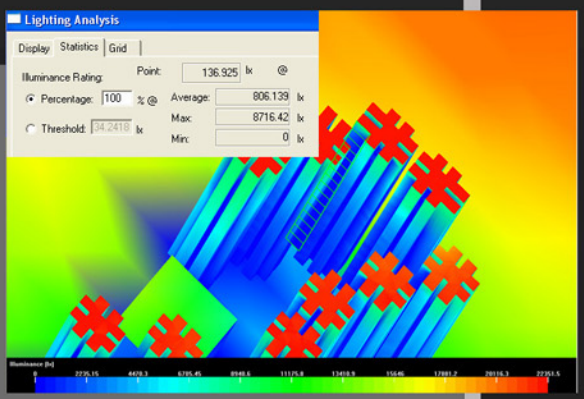
# SIMULATION OF DAYLIGHT

Software Lightscape is used to simulate the daylit environment in the Tak Bo Garden.

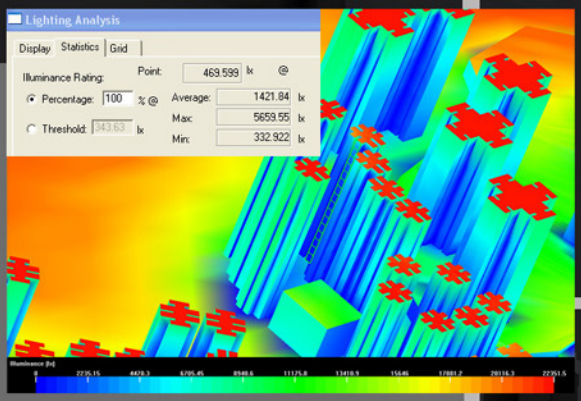
In this model, the average reflectance of the external walls is 0.28, and the value for the ground is 0.12. The simulation employed a cloudy condition, all the unobstructed horizontal surfaces receive 22347lx from the environment. According to the layout of Tak Bo Garden, units facing the patio have lower illuminance. The readings have been taken in middle of the two bottom unites facing the patio. For Block C unit 5, a value of 137 is read somewhere near the ground, VDF of 0.6%. Block E unit 6, has a illuminace value 470lx, VDF 2% on the external wall of low floor. (Deal to reflectance, a high value, more than 500lx, is read somewhere near ground in this block.)  From the plan, we can tell that these two points are the location of a living-room or bedroom. According to recommendations of a minimum 8% VDF for habitable space and minimum 4% VDF for kitchens, some units in Tal Bo Garden have serious problems of daylit environment.





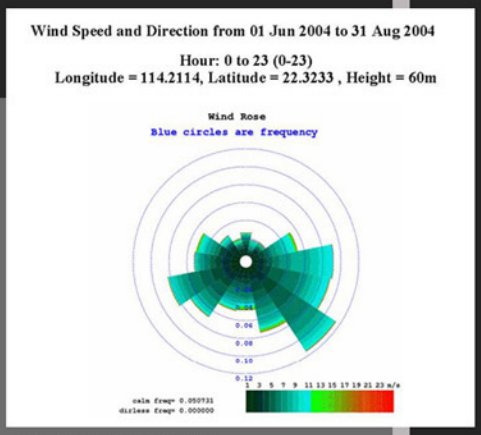




## LAYOUT AND VENTILATION

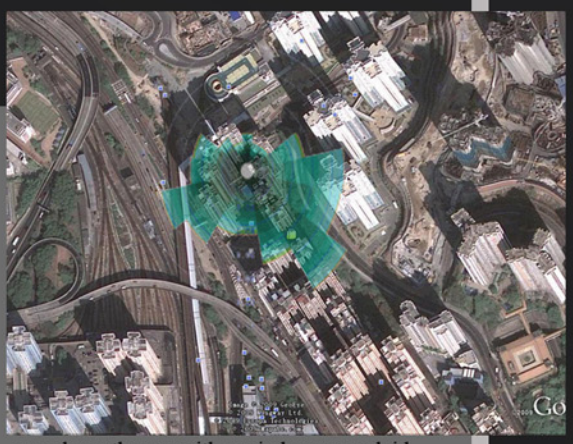
From the wind rose in summer at 60m height for Kowloon Bay area, we can tell that the regional wind in the hot and humid season is from a southeast direction. If we overlay the wind rose on a Google Earth map of this block, we can know better about the relationship between building layout and the ventilation in Tak Bo Garden.

As presented on the map, when the summer wind comes from the southeast, the street direction(located on the east of Tak Bo Garden) and the layout of nearby buildings actually strengthen this trend. When the wind arrives at this community, it is largely blocked by the buildings on the east. This is because the east-located buildings are parallel to the wind direction, and very close to each other with almost no gaps in between. (This can be seen clearly on the plan: the east side buildings are approx. 22m * 19m wide, and 33-floor height, but the biggest distance is only 3m.)  It is therefore quite difficult for the summer wind to enter the community. The density of the buildings in this community also the main reason for daylit problems.



wind rose for this area


plan for Tak Bo


google earth map with a wind rose overlaid

EXISTING PROBLEMS

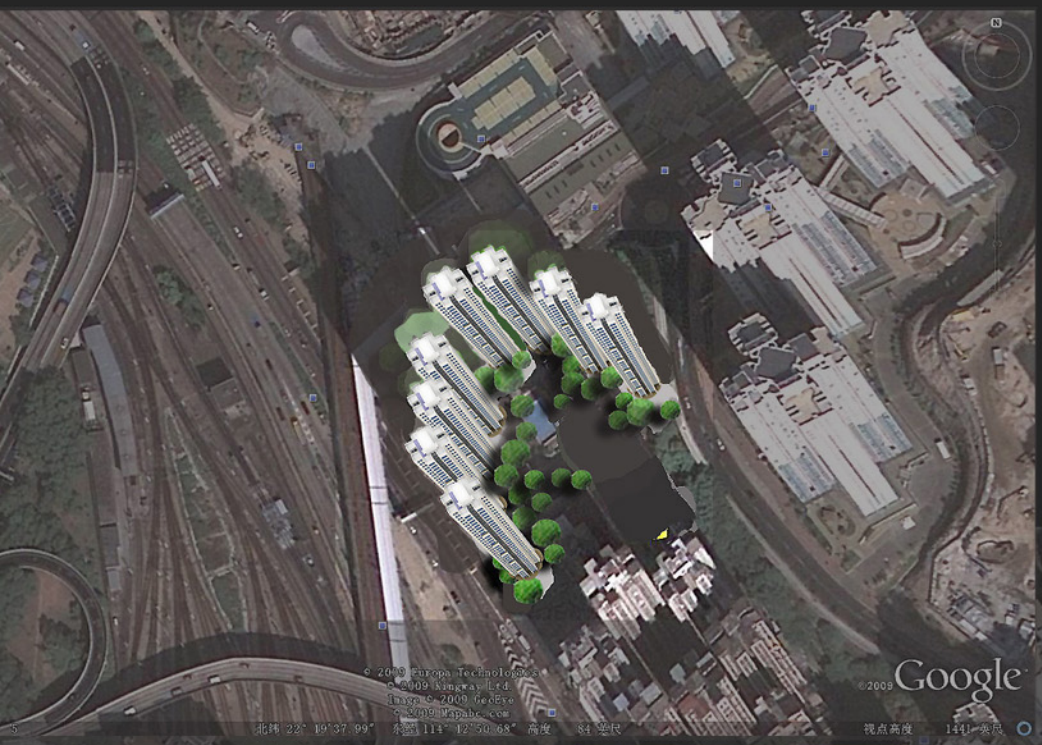
Daylight Environment:

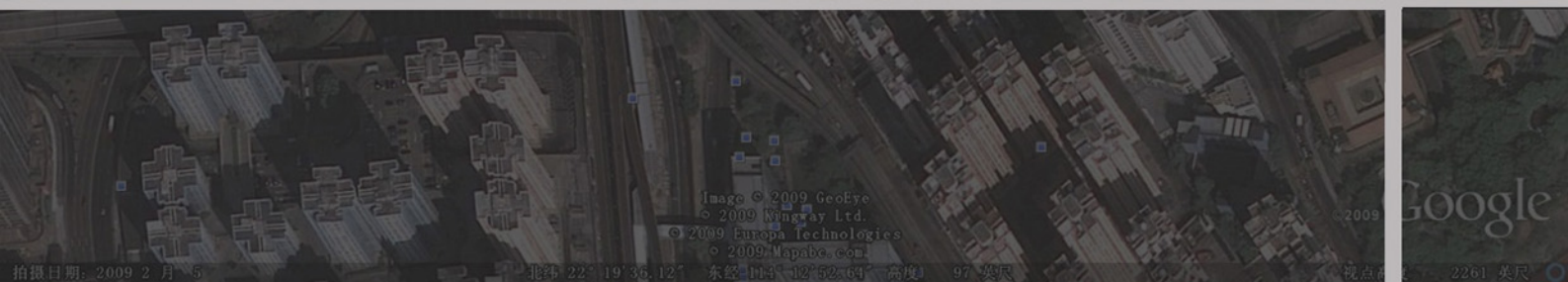
1. A small open space for 2,016 units, leading to serious self blocking between buildings and a very low value of UVA for those residences facing the inner garden.
2. The buildings are densely built up, the plan for the building is approx. 22m * 19m, but there is only a 2m small gap between 120m height buildings. For some buildings, there are even no gap in between. This causes problems not only for daylighting issues but also in ventilation.
3. The external walls of the buildings are quite old and a grey color. The ERC would be relatively lower. Many windows of the residences are dirty , making the interior even dimmer.

Natural Ventilation:

4. There are almost no gaps between east side of the buildings, blocking the prevalent wind in summer (southeast in the area, the direction strengthen by the layout of the surrounding buildings.But the layout of the buildings inside the community is like a wall that blocks out the wind). It is a liability from the ventilation aspect since it would be difficult to catch the wind in summer.

# IDEAS FOR IMPROVEMENT



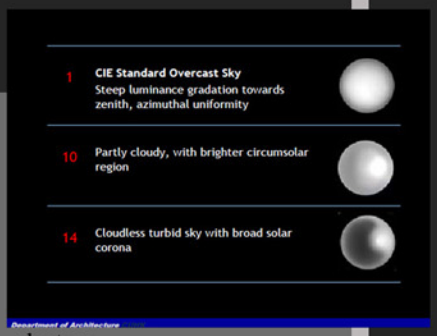



# DESIGN ISSUE

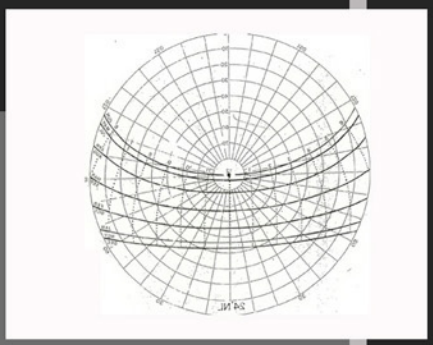
*Comment from Residents:*

*Some residents left comments on Tak Bo Garden left on the Internet. One said he once lived in Block B, but the unit was too tiny, walls were very thick, and the windowsills were big. Another one said her unit is very humid, with water leaking on the external walls.*

Hong Kong has a humid and subtropical climate, which greatly affects the building design in this area. Cloudy days are very common in this city, so during this time solar radiation is more even from all the directions(See the sky type), and requires a certain distance between buildings to get enough daylight for either outdoor or interior environment. Sometimes a good plan can make optimization without sacrificing Volume Fraction. In winter, when sunshine is desired, the amount of cloud in the sky decreases and the sun shines at a 45° angle in December.(See the sun path for HK.) Hong Kong has a mild and short winter but a very long period which is hot and humid. People suffer from this climate most of the year. So ventilation is extremely important in Hong Kong and should be considered in any design process. ventilation can normally decrease the temperature of the indoor environment and even under some situations that can not, it can still mitigate the heat stress. Besides, the flow of air can accelerate evaporation and drive away water droplets during humid days, so ventilation is very important for thermal comfort in this type of climate. According to the data from the HK observatory, the hot nights (temp.≥ 28°c ) are concentrated in June to September; in the rest of the year, night time cooling by ventilation is possible and necessary for some of the months.




sky type



sun path for Hong Kong

**Monthly Relative Humidity, Dew Point Temperature, Wet-bulb Temperature and Vapour Pressure Recorded at the Observatory between 1971-2000**

| Month | Relative Humidity (%) | | | Dew Point Temperature (deg. C) | Wet-bulb Temperature (deg. C) | Vapour Pressure (hPa) |
|---|---|---|---|---|---|---|
| | Mean | Mean at 0200 hours | Mean at 1400 hours | | | |
| January | 73 | 78 | 65 | 11.0 | 13.5 | 13.7 |
| February | 78 | 82 | 71 | 12.2 | 14.4 | 14.8 |
| March | 82 | 86 | 75 | 15.5 | 17.0 | 18.2 |
| April | 83 | 88 | 76 | 19.4 | 20.5 | 22.9 |
| May | 84 | 88 | 77 | 22.7 | 23.7 | 27.8 |
| June | 82 | 86 | 76 | 24.5 | 25.6 | 30.9 |
| July | 81 | 85 | 74 | 25.0 | 26.1 | 31.7 |
| August | 82 | 86 | 75 | 24.9 | 25.9 | 31.5 |
| September | 79 | 83 | 72 | 23.4 | 24.7 | 28.9 |
| October | 74 | 78 | 66 | 19.9 | 21.9 | 23.8 |
| November | 70 | 75 | 61 | 15.3 | 17.9 | 18.1 |
| December | 69 | 74 | 60 | 11.6 | 14.5 | 14.4 |
| Year | 78 | 82 | 71 | 18.8 | 20.5 | 23.1 |

climatic data for Hong Kong

**Number of Hot nights observed at the Hong Kong Observatory**

(criteria: daily minimum temperature >= 28.0 degrees C)

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1999 | - | - | - | - | - | 2 | 12 | 3 | - | - | - | - | 17 |
| 2000 | - | - | - | - | - | 6 | 6 | 10 | - | - | - | - | 22 |
| 2001 | - | - | - | - | - | 2 | 2 | 10 | 2 | - | - | - | 16 |
| 2002 | - | - | - | - | - | 8 | 7 | 2 | - | - | - | - | 17 |
| 2003 | - | - | - | - | - | 5 | 10 | 4 | 1 | - | - | - | 20 |
| 2004 | - | - | - | - | - | 7 | 7 | 5 | - | - | - | - | 19 |
| 2005 | - | - | - | - | 2 | 5 | 10 | 5 | 4 | - | - | - | 26 |
| 2006 | - | - | - | - | - | 3 | 9 | 1 | 2 | - | - | - | 15 |
| 2007 | - | - | - | - | 2 | 3 | 14 | 4 | - | - | - | - | 23 |
| 2008 | - | - | - | - | - | - | 7 | 1 | 7 | - | - | - | 15 |
| 2009 | - | - | - | - | - | 2 | 4 | 15 | 7 | - | - | | |

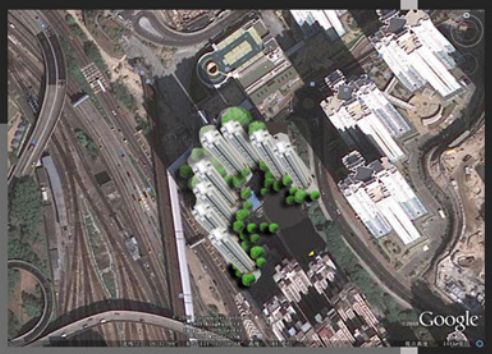
number of hot nights

# DESIGN IDEAS FOR IMPROVEMENT (1)

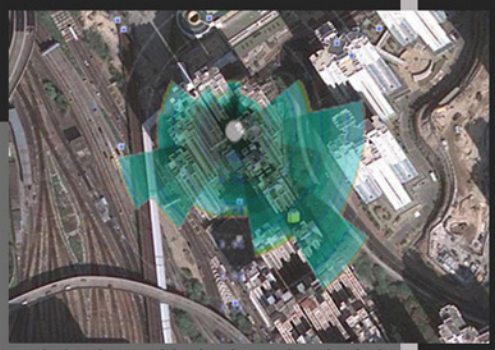
***Open A Wider Angle to The Southeast:***

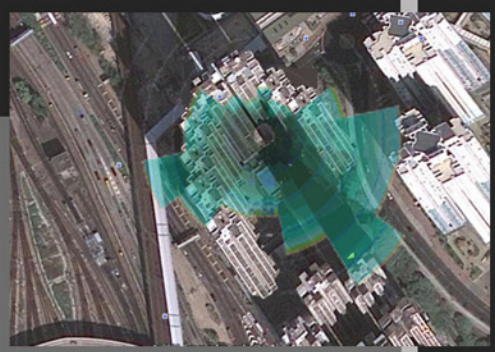
The main reason for the poor ventilation and daylit environment in this community is, the layout of the buildings. The buildings are densely built with small gaps in between, and the direction is parallel with the regional wind. Based on this, one of the ideas for improvement is to change the layout into a figure in which a bigger angle to the southeast is formed. In Hong Kong, the elevation angle in winter is 45°from the south. A wider angle facing southeast would allow more winter sun shine into the community, and also more surfaces and windows can “see the sky” to get more daylight for the indoor environment. On the other hand, the surfaces of the buildings should be painted into a bright and light color to increase external reflectance. The wider angle is also important regarding the prevailing wind direction. In the existing layout, the east side buildings are tall and densely built with almost no gaps. They block the wind from entering the community. So the idea is to reduce the east side buildings and increase the distance at the same time. When the southeast wind passes by the nearby buildings and street and comes to the community, there will be no barrier on the southeast, and also a rather big gap locates in the northwest of the community as a outlet. So a wind path through the whole plan is formed. Although the northwest side of this community now turns into a great suction zone because it is located in leeward area, but considering it is only a wide traffic road and a large open area in this area, the negative impact should be quite limited.

existing layout for Tak Bo Garden



a new layout for improvement


existing layout blocks the regional wind


wider angle for winter sun and ventilation

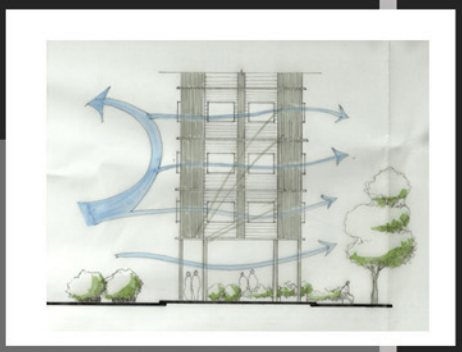
# DESIGN IDEAS FOR IMPROVEMENT (2)

***The Bigger Possibilities, An Oblique Angle to The Wind and Leaving The First Floor Open:***

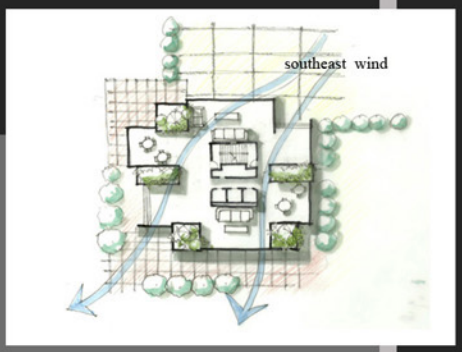
After the wind enters the community, the next step is to find a way to find a correct orientation for single building regarding to the wind direction. The idea is to make an oblique angle between wind direction and single building. Under this condition, the windward surfaces of the buildings will be in higher pressure zone while the leeward surfaces be in lower pressure zone. The gradient is a force for horizontal ventilation through the building. And in Tak Bo, buildings have windows on every facade and internal doors on partitions, so the wind can flow into every unit of different directions. (See one of the east side buildings as an example.)

For this particular community, because the land area is limited, the distance between the buildings therefore cannot be an unrestricted number. So the lower-floor units are inevitably dimmer. Considering this and the humid climate in Hong Kong, to leave the first floor open may be a better option than letting people live in a dark and humid environment. The first floor will be a semi-open area and increase the green area in the community. If it can be connected with the inner garden, then a bigger public space is created for residents. In this idea, these eight buildings will be more connected to the surrounding environment and the ventilation in the community can be largely improve.


oblique angle to the wind



leaving the first floor for ventilation and activities




plan for the first floor

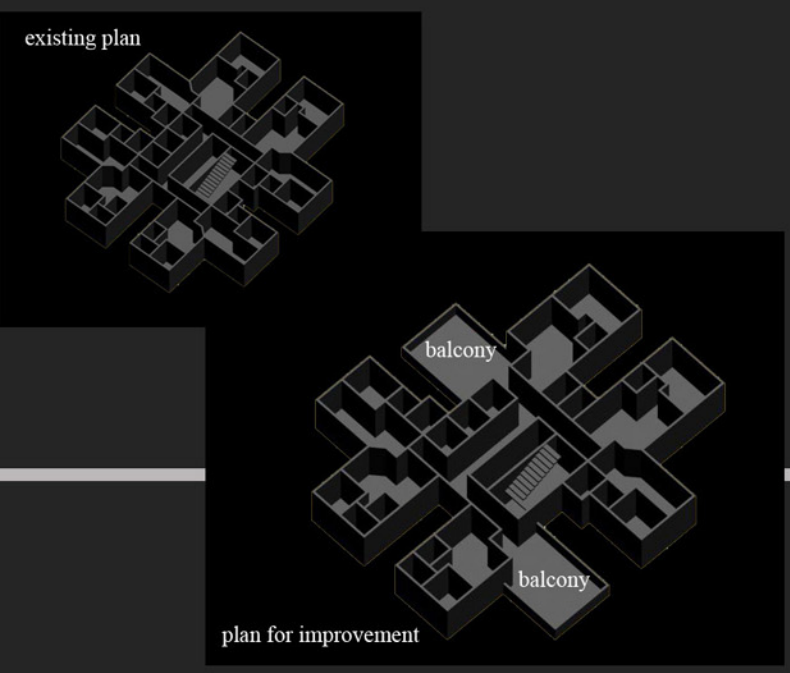
draft for the first floor

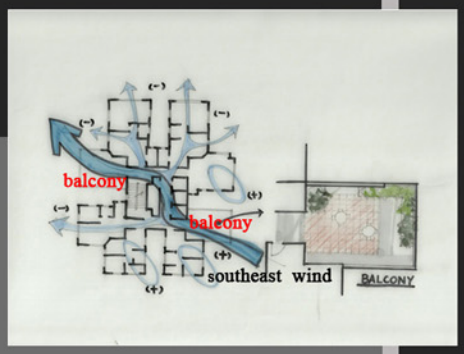
# DESIGN IDEAS FOR IMPROVEMENT (3)

***Balconies on the middle floors***

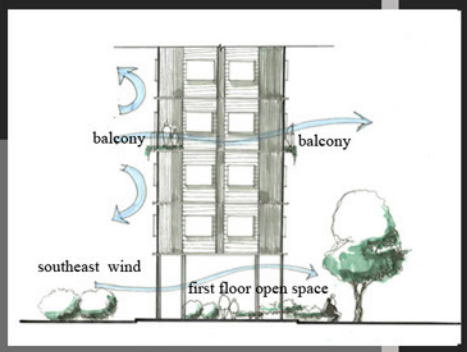
A correct relationship between the direction of the buildings and the regional wind only gives out the possibility of ventilation. In the reality, whether or not the fresh air can flow into the building also greatly depends on the arrangement of rooms inside. For Tak Bo Garden, there are many windows on the facades, which can help air to enter the residential units; but there are also many rooms and partitions in between, they may disturb the procedure. Besides, sometimes the plan could be too deep for a gentle wind to go through the building and comes out at the other side. Several balconies on the middle floors of the buildings can be helpful to bring more wind into the units. The idea is for every five floors, there will be two Balconies located on a diagonal line of the same floor, regarding to the wind direction. The air flow is assumed to travel deeper into the building in a faster velocity because the existing of the balconies. It is like creating a big inlet and outlet along the wind direction to form a path.

People in Hong Kong are used to hanging up the clothes after washing them, but normally they cannot find a proper place to do it. A public balcony can be a perfect place for this and also good for social activities among neighbors.




Plan for floor with balconies




bring ventilation into the whole building

blocking wind and daylight

NO options

REFERENCE: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2. Victor Olgyay, *Design with Climate*, PRINCETON UNIVERSITY PRESS

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4. Professor Lutz Katzschner , Handout from MSc Urban Climate Course 2009

5. http://gb.weather.gov.hk/abouthko/logoexplain/logoexplainc.htm