

## Sustainable Design in Public Housing

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### **Introduction**

Public Housing in Hong Kong has significantly shaped our built environment and has provided over 900,000 public housing units, accommodating nearly half of the population. The move of public housing towards sustainable design is therefore a challenging task.

Environmental concern is nothing new for the Hong Kong Housing Authority (Authority) and environmental friendly practice is an important consideration. As a continuous effort to contribute to a better environment, the Authority is working towards the all-embracing goal of sustainability in public housing.

In this paper, I shall discuss sustainable design in the context of public housing, the underlying factors which contribute to sustainable public housing, as well as the multi-faceted issues involved. I shall also share our experience in attempting to achieve sustainable design in some of our recent projects.

### **What is sustainability?**

Despite the fact that there is no consensus on a universal definition for sustainability, the broad concept has been commonly interpreted as: to meet the needs of the present without compromising the ability of future generations to meet their own needs (Brundland, 1987)<sup>(1)</sup>.

In Hong Kong, one of the first official work on the subject of sustainability was a government commissioned consultancy study in 1997, the Study on Sustainable Development for the 21<sup>st</sup> Century (SUSDEV 21), which came up with the following definition:

“Sustainable development in Hong Kong 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.”

The definition was used for reviewing the sustainability performance of various government policies, projects and programmes. However, sustainability or sustainable development has really become a hot topic after the Chief Executive's 1999 Policy Address, which has set sustainable development as a key policy objective. In the 1999 Policy Address, sustainable development for Hong Kong was defined as:

- Finding ways to increase prosperity and improve the quality of life while reducing overall pollution and waste.
- Meeting our own needs and aspirations without doing damage to the prospects of future generations; and

- Reducing the environmental burden we put on our neighbours and helping to preserve common resources.<sup>(2)</sup>

With all the many different definitions, the key elements for sustainability which we could summarize as: **to meet present social, economical and environmental needs but not at the expense of future generations.**

### **On-going Green Construction Practice**

Environmental consciousness, quality, durability, adaptability, efficient use of resources have always been key considerations for the design and construction of public housing. For years, a number of effective measures have been employed to enhance environmental protection. Examples are:

- Replacement of traditional timber formwork with large panel formwork for the last 15 years and also replacement of timber hoarding with steel hoarding. As a result, the use of timber in construction is significantly reduced.
- Prefabrication of building elements such as pre-cast facades, staircase, panel walls, doorsets for more than 10 years. This enables efficient and fast construction, effective quality control and waste reduction.
- Installation of automated refuse collection system (ARCS) has significantly improved hygiene and cleanliness.
- Segregation of waste material on demolition sites so as to enable recycling of the material for reclamation use and reduce dumping in the landfill sites.

Our effort in environmental protection would not be confined to current measures. Continuous improvement is always our aim. The changing and inter-relating social, economical and environmental conditions of the society would also serve as driving forces for further development in sustainable design and practice.

### **Social Aspirations**

Expectation of the public for improved living standards is rising. Public housing has to meet today's expectations for better internal living spaces as well as a pleasant external environment for enjoyment and social interaction. A decent living environment contributes to a sustainable community in the long run.

A housing unit must also be able to cope with the different spatial needs associated with the growth and aging of occupants, and changes in family structure. Flexibility and adaptability in the design of flat unit are important considerations to meet the changing needs of people.

There is also changing demography of society as a whole. Flexibility in public housing design allowing changes in the flat mix within a housing development at various stages of the project is required to cope with the changing needs of the society.

The building height of residential building has been increasing roughly at a rate of ten storeys a decade. Community life in a vertical dimension is called for. Properly designed

communal space, sky gardens and landscape areas in the vertical community would be important means to improve the living environment in high rise housing.

### **Economical Considerations**

The population grows at roughly a million every decade in Hong Kong. With limited land resource, further increase in density and height of housing development is inevitable. Providing a quality living environment in high-density high-rise developments is a real challenge.

Value for money is an extremely important consideration for public housing, for it serves the mediating role of providing affordable housing. Yet with the tight budget, high performance has to be maintained, through careful design to ensure quality of the living environment, efficient construction process, low maintenance and efficient operation.

### **Environmental Protection**

One of the most important issues of sustainability is to protect our environment so that our future generations can also enjoy it, hopefully as much as we do now. The use of recycled materials, materials from renewable sources, and renewable energy all help conserve our precious resources. Improving the energy performance of a building can reduce energy consumption, which also directly reduces emissions from power plants. It relies on a design with better natural ventilation and a lit environment. By doing so, the operating cost for the building will also be reduced, enabling a lower life-cycle cost.

Landfills in Hong Kong have been filled up at an unexpected fast rate, with more than one third coming from construction and demolition materials. Recycling demolition materials and reducing waste production are sustainable and long-term solutions. Prefabrication, modular design and mechanized construction can largely reduce the amount of construction waste while ensuring better quality. Minimizing the extent of waste from fitting-out of newly occupied flats by careful flat design to suit tenants' need would also reduce construction waste. Certainly, good construction management is also vital in reducing pollution and waste from construction process.

### **Setting the goal for sustainability**

In response to the call for environmental enhancement, an Environmental Committee was set up by the Authority. Some of the environmental targets concerning development and construction are:

- Apply Hong Kong Building Environmental Assessment Method (HK-BEAM) environmental design criteria in all new projects and warrant a good rating so as to ensure the environmental qualities of the design.
- Reduce water consumption through innovative building system such as gray water recycling system and use of water saving sanitary fittings.
- Increase the use of environmental friendly building materials and recycled materials through market research and specification review.

- Minimize construction waste by further increasing the proportion of pre-fabrication, modular planning and design and introducing purchasers' choice to reduce removal of fixtures and fittings from newly occupied flats.

## Further Opportunities

Apart from the environmental targets, the recent Quality Initiatives of the Authority, particularly the call for wider use of site specific approach in housing projects has largely facilitated sustainable design in public housing. New areas for achieving sustainable design could be incorporated which would not have been possible by the use of standard blocks, which may have had a difficulty in addressing the environmental characteristics of individual sites.

In February 2001, the issue of the Joint Practice Note No. 1 (JPN) by the Buildings Department, Planning Department and Lands Department provides further opportunities to incorporate green features in buildings, like balconies, wider common corridors and lift lobbies, communal sky gardens and communal podium gardens, etc. Exemption from counting for development area for these green features has been an effective incentive.

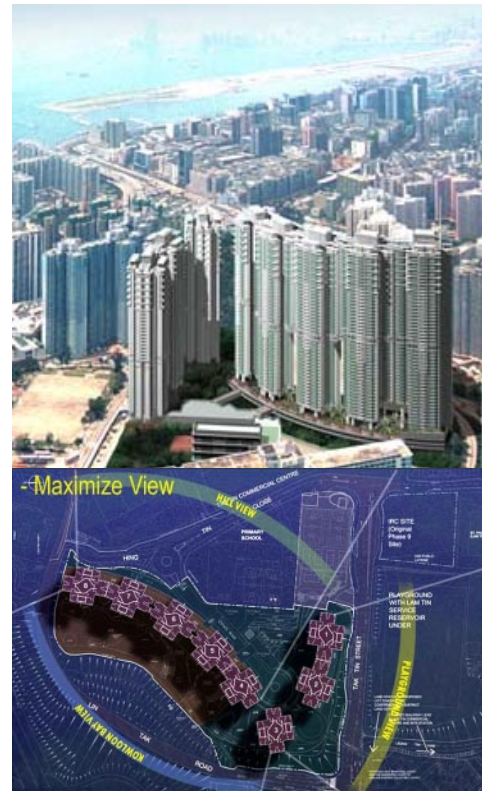
The Building Innovation Unit of the Buildings Department is also looking into further means to encourage environmental friendly building and construction. Additional incentives would surely offer further opportunities for better sustainable design.

## Site Specific Housing Projects

Site specific approach allows the possibility of optimal design by balancing the social, economical and environmental needs, resulting in a higher level of sustainability in our public housing.

### Master Planning

The master layout could be moulded to respond to the characteristics of a particular site. View opportunities could be maximized and overlooking minimized. Building could be designed away from noise sources. Building blocks could also be orientated to suit the microclimate of the site, such as prevailing wind and sunlight. The environmental



Lam Tin Phase 7&8: master layout respond to site factors



Above: Shui Chuen O Design Competition Entry – Outdoor space for specific users  
Below: Redevelopment of Hung Hom Estate Ph.2 - Terraced garden, areas of interest

qualities of the development and thus human comfort could be ensured.

Site specific design also enables an integrated approach in master planning. Open space could be designed with due considerations for microclimate, human comfort, enjoyment and vista location. The result is a lively communal space of interaction and enjoyment. Introduction of sky gardens and urban windows at upper levels becomes important. This would not only improve the microclimate around the building blocks, but also enhance social contact in the vertical mode of living in high-rise building. This also contributes to attaining a sustainable community.

### *Block Design*

With site specific approach, higher efficiency could be achieved which implies more economical use of resources. Ventilation and lighting to the common areas such as lift lobbies and corridors could also be enhanced, thereby reducing energy consumption. Local adjustments of the building blocks would also be possible to address specific environmental issues such as noise problems. Adaptability of a housing block to changing flat mix requirements is also explored. Structural input is important for facilitating such adaptability.

### *Flat design*

Flexibility in flat internal layout to suit different spatial needs of occupants is another area of focus. Again, an effective structural design would enable the free relocation of internal partitions according to different spatial needs. Real size mock-up of the flat units has been used to help rationalizing every inch of internal space. Facilitated by JPN1, introduction of balconies improves the cross ventilation of flat interiors while serving as sun shading devices at the same time.

### *Environmental performance*

Computer modeling and simulation techniques are valuable tools for evaluating the environmental performance of building design. Study such as solar heat gain provides essential information for improvement by introduction of shading device or adjusting size of windows, etc. Other studies include visual comfort and natural daylight which help to ensure human comfort in the flat interior. These tools also facilitate engineering studies for new design approaches where modifications to the current building regulations may be required. Wind tunnel test has also been used in our recent projects to obtain more accurate information on prevailing wind direction and effect of surrounding development and topography for use in subsequent computer simulations.



VENTILATED LIFT LOBBY

Shui Chuen O Design Competition



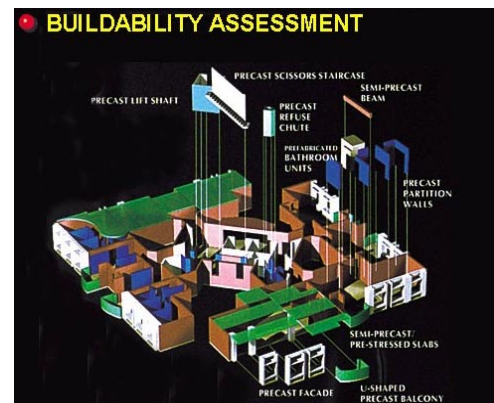
Lam Tin Phase 7&8: Studies on possible internal layouts

## *Buildability*

Emphasis has been put to improve buildability. In some projects, the total reinforced concrete prefabrication percentage was increased to 15% as compared with 12% in standard blocks. New prefabricated elements like pre-finished prefabricated wall panels and prefabricated kitchen and bathroom units are being studied. Flat modules are also carefully designed so that efficient mode of mechanized construction can be adopted to achieve fast construction, high quality and lower cost.

## *Building Services Installations*

A carefully designed building could reduce the extent of building services required, thus reducing cost and energy consumption. Carport layout could be carefully planned with a ventilation space in the center so that efficient ventilation can be achieved and the need for mechanical ventilation system minimized. In some other new projects, we are also looking into the application of a number of green building services systems, such as water saving cisterns, building integrated photovoltaics and gray water recycling system.



Shui Chuen O Design Competition



Redevelopment of Hung Hom Ph.2 – environmental considerations of carport podium design

Allowance for the future development in IT is another important consideration, so as to allow future generations to enjoy the technology of their time without difficulty. Future wiring for IT systems is made possible by providing additional ducting and service stations.

## *Choice of Building Materials*

The wider use of recycled and environmental friendly materials is also being looked into. Examples are self-cleaning tiles, recycled paving bricks and timber from farmed renewable sources.

## **The Issues Involved**

### *Costing*

Up to now, the cost of housing development is still evaluated based on the initial cost. However, sustainable measures inevitably involve higher initial capital cost although there would be lower operation and maintenance cost in the long run. Therefore, adoption of life-cycle cost assessment is essential for the move towards sustainable design. The Authority is carrying out studies in life-cycle costing, but it may take some time to reach implementation stage.

For site specific projects, the cost budget is set at 5%-10% above the standard design.

With such a tight budget, it will be difficult to incorporate many of the sustainable design provisions. Many difficulties were experienced in the site specific projects during detail design and tendering stages with the inevitable higher cost than standard design. Early implementation of life cycle costing is a priority need.

### *Programme*

Under current construction practice, site specific design would inevitably require a longer design, consultation and construction period. Depending on the project complexity, the lead-time for a site-specific design would be at least 3 months longer than standard design. To meet the large housing demand, careful consideration on the supply is required when deciding if site specific approach should be adopted for a particular housing project.

### *Codes and Local Regulations*

Despite the fact that most green systems such as photovoltaics are not newly invented systems, there are still a lot of limitations on their applications. Efficiency of the products, ease of application and high cost of product are yet to be improved. However, it is even more important to formulate codes and regulations which facilitate the application of green systems in building projects. Despite all the difficulty, we are still looking for possibility of application of such systems in our housing projects hoping to take a lead to promote application in the industry.

### *Staff Resources*

Site specific design generally requires much more staff resource in design, contract documentation as well as site supervision. It is necessary to deploy and manage our staff resource to meet the different needs of carrying out site specific designs. The same applies to other professional disciplines in the construction industry. Due to limited staff resource, about 30% of the projects may adopt site specific approach at the present moment. We may need to review the overall impact on our staff resources and the need for organizational strengthening to cope with the need.

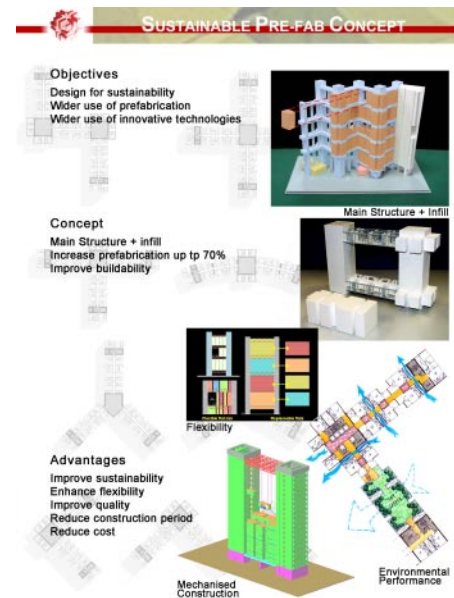
## **Time to Rethink**

Experience in a number of site-specific projects is that there is still room for our housing developments to be designed to enhance sustainability. This can be fulfilled with the support and aspirations of society, the incentives in the JPN, the adoption of site-specific approach in our housing development and the availability of tools and technologies. However, there are constraints to be overcome. Amongst the constraints, the higher cost and an often longer lead time are surely two most important issues that we have to overcome as we have to work with our relatively low cost yardsticks and tight lead time.

The merits of the standard blocks are low cost and short lead-time which are direct results of economy of scale and consistency of standard. However, sustainable design is best achieved in site specific projects which could be designed to suit the environmental characteristics and various factors of individual sites, but often with time and cost implications. In order to enable sustainable design in all our housing projects, a rethinking for an approach that can encompass the merits of both standard blocks and site-specific approach is probably called for.

How could this be achieved? We think that a possible solution is to further develop the concept of modular units of our standard block, adopt a wider use of prefabrication and industrialize the prefabrication process to achieve diversity and quality in products. Hopefully through these measures, we could find a way that we could have flexibility for sustainable design, yet with a lower cost and shorter lead time as a result of the modularization of flat units and wider use of industrialized prefabrication in the construction process.

In one of our recent site specific projects, the above concept is being investigated. Pre-finished prefabricated units are designed as individual elements separated from the main structure of the building. By this arrangement, the prefabricated units themselves would be required to carry localized load only and as a result wider use of 3D modular prefabrication in a high-rise building becomes possible. With the industrialization of prefabrication plant, variety in the 3D prefabrication could be achieved without sacrificing cost control. This 'structure and infill' concept also gives great flexibility for incorporating green provisions like sky gardens, urban windows and communal green space at upper floors of high-rise housing. The most important benefits are that cost would be lowered in long term due to wider use of prefabrication. Overall construction period could also be reduced due to the possibility of non-sequential construction process. With a comparable cost and lead-time, the adoption of sustainable design in site specific housing development would address our client and tenants' needs.



Sustainable Pre-fabrication Concept under development

## Way Forward

Sustainable housing design requires a holistic approach. Participation and contribution of all construction stakeholders are essential. We would require new design considerations in our master layout, block design and flat layout. New frontiers in structural design have to be achieved. Investments in prefabrication plants and industrialization of the prefabrication process are essential. Highly organized site logistics and management and new procurement methods in tendering and contracting will also be required to try out new concepts and advanced construction technologies. Success would not be far away, when we all have a common goal to create a sustainable living environment for the enjoyment of our present and future generations.

### References

1. Edwards, B., Turret, D. (2000), Sustainable Housing Principles & Practice, Chapter 1 pp.19
2. HKSAR (1999), Address by the Chief Executive, the Honourable Tung Chee Hwa, Quality People, Quality Home pp.29

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